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THE PRESENT STANDING OF THE FLORIDA MANATEE, TRICHECHUS LATIROSTRIS (HARLAN) IN THE INDIAN RIVER WATERS.

BY OUTRAM BANGS.

The last two generations have witnessed such a destruction of animal life in this country that it is appalling to look ahead and see what the future has in store for us. Our larger animals and birds are going with such rapidity, and the wilder parts of the country to which they have been driven are being cleared and settled so fast, that the end of many species, still common in places, is already plainly in sight.

Man is, of course, the real cause, in almost every case, of the extermination of a species, although often the end comes by some natural calamity, as, for example, the tragic end of the Great Auk.

When a species has become, through the persecution of man, reduced to a mere remnant that persists either from the inaccessible nature of the country to which it has taken refuge. or from the wariness the few surviving individuals have developed, it takes but a small change in its surroundings to wipe it forever from the face of the earth.

The winter of 1894–95 has been a most disasterous one and has shown us on how slight a change in temperature the life or death of a whole species depends. Two such winters in

succession would in all probability exterminate the blue-bird, the snow-bird and many others that winter in the Carolinian Zone. These birds went into the winter in their full numbers and strength, and yet this summer they are so rare that I have not seen a single blue-bird in the Plymouth Co. Mass. country, where usually they are one of the common breeding birds. Think what a proportionate reduction in numbers must mean then to a species already on the verge of extinction.

The cold in Florida of the last winter was unprecedented and the mortality among the fish in the shallow water was such as I never thought to witness. The birds suffered very much, but as far as I could tell few died as far south as where I was, Oak Lodge on the East Peninsular opposite Micco. Here, at five o'clock, on the morning of February 12th, the thermometer registered 20° Far., and on the next morning at the same hour, only 23°. It was a strange experience to walk over the frozen sand and see every little puddle covered with ice, on a trail overhung by the sub-tropical vegetation of a Florida hammock with a north wind blowing in my face that chilled me to the bones. The cold of these two days and nights was intense.

On February 19th, Mr. Walter L. Gibson came across the river to tell me he had found two manatee that had been killed by the "freeze," and the next day I went over to take possession of them. They were both found where they had floated ashore on the bank of the Sebastian River, one about four and the other two miles from its confluence with the Indian river. I found to my great regret that both were too far gone to hope to save the skins and the only thing to be done was to save the skeletons which we began to macerate out at once. One was an old female of very large size, measuring from the end of the nose to the end of the tail 11 ft., 4 in. The other, a young male, measuring from the end of the nose to the end of the tail 6 ft., 4 in.[1] Both skeletons are now in the collection of E. A. and O. Bangs, Boston, Mass.

[1] The Florida Manatee grows but little larger than this female. The two largest I ever heard of were two caught in the St. Lucie River, by Mr. August Park of Sebastian, Florida. One in August, 1880, that measured 13 ft., 7 in. long, and one in June of the same year, that measured 12 ft. long and estimated at two thousand pounds weight.

These Manatee were two of the survivors of the herd of eight, which had, for the past year, been living in the St. Lucie and Sebastian Rivers and that part of the Indian River which is between these two. For two years the Manatee has been protected by a State Law and this herd had come together in consequence and probably consisted of most of the Manatee of this region that, freed from persecution, had collected into a herd as was their wont in old times when the rivers were theirs.

Mr. Gibson told me that often he has stood on the railroad bridge that spans the Sebastian, and seen this herd pass under him and counted them over and over again and knew every individual in it. After the first "freeze" of last winter, in December, three of the Manatee were found ashore, dead, in different places and no live ones were seen. Whether any of this herd pulled through both "freezes" is impossible to say but five out of the eight are accounted for and it seems likely that more died than were found, as a great part of their range was not covered and their carcasses might easily have escaped detection even in places that were visited. It does not take long for a dead body to disappear in Florida and the Manatee as they lay half under water would soon have been disposed of, the crabs doing the business below the surface and the turkey buzzards above.

The Manatee is extremely sensitive to a change in the temperature of the water. This was noticed by Mr. Conklin to be the case with the one that was kept alive in the Zoological Park in New York and Mr. C. J. Maynard told me that he knew of three large Manatee that were killed in the "freeze" of 1886 and washed up near Palm Beach. The 1886 "freeze" was very mild compared with those of last winter. In 1886 the mangroves hardly suffered at all, while last winter, 1894 and 1895, nearly every tree along the whole stretch of the Indian River was killed to the ground.

In both "freezes" last winter the cold came without any warning and the change of temperature was so sudden that the only chance for the Manatee to escape certain death lay in their being able to reach deep water before they were overcome by the cold.

The region from the Sebastian to the St. Lucie has, for a number of years, been the only part of the Indian River where the Manatee were seen. Here, besides the herd of eight, now reduced to three at the very outside, there were some solitary scattering individuals, how many it is impossible to say, as the Manatee has become very shy, but it is safe to assume that the scattering ones fared no better than did the herd, and that the reduction in numbers from the cold of last winter was very great.

There are still, however, a few Manatee alive in the Sebastian River. In a letter I lately received from Mr. Gibson he told me that in the end of March he surprised several Manatee lying close together on a mud flat, high up the Sebastian River. As soon as they heard him they made a rush for deep water, throwing the mud and water fifteen feet high in the violence of their flight.

I made many careful inquiries among the people who live along the river and would be in the way of knowing of the Manatee and its diminution of numbers of late years, but got surprisingly little information of any value except from Mr. Gibson, to whom I have so often referred, and Mr. Fritz Ulrich, a German of more than ordinary intelligence, who has spent the last fifteen years dreaming his life away among the birds and animals of the Indian River. They were all his friends. The panthers knew his voice and answered him from the wilderness, and the owls came from their hiding places and flew about him to his call and the little lizards fed from his hand. But it is all gone now and there only remains of the great life of the river a small terrified remnant, and in its stead the railroad train hurries along the west bank and hideous towns and more hideous hotels and cottages have sprung up everywhere among the pines. It is now eight years since Mr. Ulrich saw a living Manatee, but when he first came to the river fifteen years ago they were still common and he often saw them from the door of his little house at The Narrows passing up and down the river and occasionally he saw them at play when they would roll up, one behind the other, like the coils of a great sea serpent.

The spring and summer of 1894 were so dry that the salt water went nearly to the head of the fresh water streams and killed out the "Manatee grass,"[2] of which the Manatee are especially fond and the poor brutes had to fall back on the leaves of the mangroves, a food not much to their liking, which they reach by laboriously dragging their huge bodies half out of water. Mr. Gibson spent a great part of that summer up the Sebastian where he was catching paraquets, and on several occasions he saw the herd of eight feeding in this manner.

The Manatee is an animal of the highest economic value and one that the Indian River, with its fresh water tributaries, seems able to support in large numbers and it would be more than mere sentiment to regret its disappearance should it become a thing of the past. But there is still a chance for it. There are some Manatee alive now in the Sebastian River and these have passed through the cold of a winter such as no living man in Florida has known before; they are protected by law, and the netting[3] has been stopped; and in spite of the small annual increase, the female bringing forth but one calf a year, it should slowly come up again to something like its old numbers.

[2] I regret that I am unable to give a more definite name to this plant, never having seen it myself, but it was described to me as a tender ribbon-like grass, the blades of which are about half an inch wide and four or five feet long. It grows with the ends of the blades and the blossoms resting on the water, and is found only in a few of the fresh water streams of southeast Florida,

[3] For a full account of this most successful method of destroying the Manatee, see an article in Forest and Stream, XIII, 1880, pp. 1005, 1006, by Mr. J. Francis Le Baron.

OF A NEW CLASSIFICATION OF THE LEPIDOPTERA.

By A. S. Packard.

(*Continued from page 647*).

Remarks on the Family Hepialidæ.—This group is assigned by Comstock, from the venation alone, to a position at the bottom of the Lepidopterous scale, even below the Micropterygidæ. By Chapman it is more correctly placed above the latter group. He even places it above the Nepticulidæ, Adelidæ and Tischeria.

Since receiving and studying Chapman's paper, it has become very plain to me that Hepialus and its allies are simply colossal Tineoids, and that Speyer was right in 1870 in suggesting that the Hepialidæ stand very near to the Tineids.[1]

These views arrived at independently by these authors are confirmed by the trunk characters, and also by the larval characters, as pointed out by Dyar,[2] and which I have been able to confirm by an examination of the freshly hatched larva of *Hepialus mustelinus*, and fully grown larvæ of the Australian *Oncopera intricata* Walk., as well as *Hepialus humuli* and *H. hectus* of Europe.

In 1863 I pointed out[3] the similarity in the head and thorax of *Hepialus* (Stenopis) *argenteomaculatus* to those of the neurop-

[1] In his suggestive paper (Ent. Zeit. Stettin, 1870), Speyer refers to the similarity of the venation of Hepialidæ and Cossidæ and remarks that they resemble the Trichoptera no less than the Micropterygidæ, though the Hepialidæ exhibit other close analogies to the Trichoptera. He adds that the middle cell of the wing in the Phryganeidæ is not fundamentally different from that of the Hepialidæ, Cossidæ, and Micropteryx, also the hind wings of Pychidæ. On p. 221 he associates the Zygænidæ with the Cossinæ, Cochliopodidæ, Heterogynidæ, Psychidæ and Hepialidæ, and remarks that all these families are isolated among the Macros; the Cochliopodidæ and Zygænidæ alike in the pupa state by the delicate integument and the partially loose sheaths, the groups standing nearest to the Tineidæ with complete maxillary palpi, forming the oldest branch of the lepidopterous stem, and having been developed earlier than the Macros.

[2] A classification of Lepidopterous larvæ. Annals N. Y. Acad. Sci. viii, 1894, p. 196.

terous Polystœchotes, and mentioned the elongated thorax of Hepialus, especially "the unnatural length of the metathorax, accompanying which is the enlarged pair of wings, a character essentially neuropterous." Reference was also made to the metascutum which is divided into two halves, being separated widely by the very large triangular scutellum. I also drew attention to the transverse venule or spur of the costal vein, and to the great irregularity in the arrangement of the branches of the median nervure, also to the elongated abdomen, and, finally, I remarked, "The Hepiali are the lowest subfamily of the Bombyces." But in those days I did not fully perceive the taxonomic value of these generalized characters, which have so well been proved by Chapman from imaginal and pupal characters, and by Comstock from the venation, to be such as to place the Hepialidæ at or near the base of the Tineoid series. Chapman, unaware of the existence of mine and of Speyer's paper, says: "The metathoracic structure of Hepialus came as a very unexpected confirmation of the idea that of the Tortricoid group, it was the nearest to the lower Adelids, and despite its specialization was near the line by which Tortrix was derived from some Adelid form." (P. 113.)

I will now refer to some characters of the Hepialidæ which further show that they are colossal Tineoids, and should be placed very near the base, though still presenting in their boring larval habits, and in the reduced maxillary and labial palpi, the entire absence of a haustellum and of mandibles, that the family (at least Hepialus and Stenopis) have undergone a considerable degree of modification, compared with the Micropterygidæ.

Beginning with the larva, that of the Australian *Oncopera intricata*, when compared with the larva of the colossal Tineid *Maroga unipunctaria* of South Australia, is the same in structure, though less specialized in the colors of the tubercles and in the sculpturing of the head, but it has the same shape of the body, the same arrangement of the 1-haired tubercles, though the setæ are smaller and shorter; and the same complete circles of crochets on all the abdominal legs.

[3] On synthetic types in insects, Boston Jour. of Nat. Hist., 1863, pp. 590–603.

In the freshly hatched larva of *Hepialus mustelinus* 1.3 mm. in length, the head is no wider than the prothoracic segment, whose dorsal plate is well developed. The mouthparts are quite large, especially the spinneret, while the hairs which are acute at the end, are in this stage as long as the body is broad. The abdominal legs appear to have at this stage only ten crochets, or at least very few.

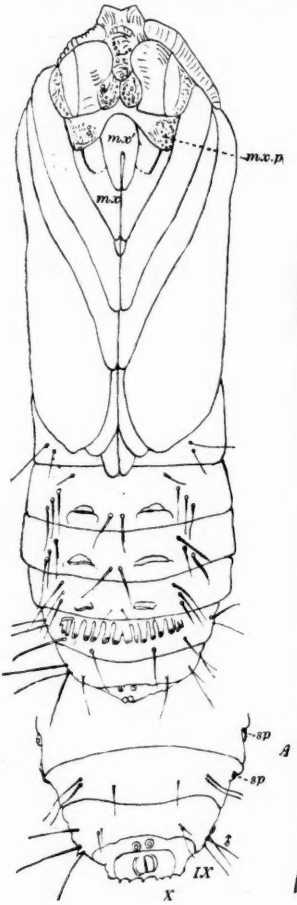
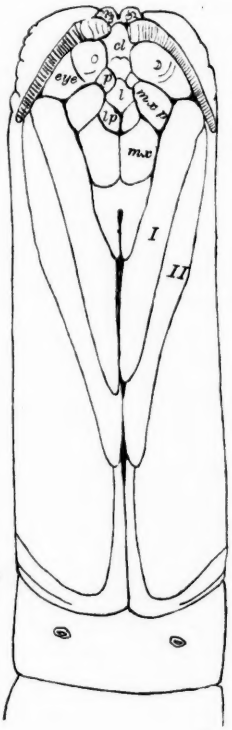


FIG. 7.



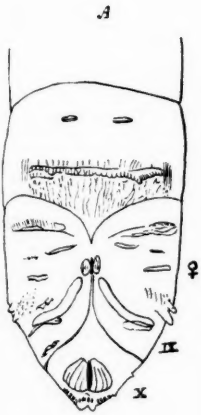


FIG. 8.

The pupa of Hepialus is said by Chapman to differ from that of Tortrix "in having the third abdominal segment free, but in a peculiar and modified manner," etc. He does not refer to the mouthparts. I have not seen the pupa of Hepialus, but have examined the pupa of the Australian *Oncopera intricata* (Fig. 7), and of the Mexican *Phassus triangularis* H. Edw., both of which present some remarkable generalized features. In the former genus, the labial palpi are visible, the entire piece is very wide at the base and is divided at the middle into the two pupal cases. Between it and the deeply lobed labrum is a piece, unless the two lobes are the paraclypeal pieces, of the nature of which I am uncertain. It is the homologue of the eye-collar, and if so, are the two lateral portions the maxillary palpi? The maxillæ themselves (*mx.*) are well developed, but at their base are divided by an impressed line, representing a portion which I am unable to name. The three pairs of feet (I, II, III) are easily identified. The outer division of the eye is large; and the cocoon-breaker consisting of two solid thick ridges on the vertex adapted for breaking out of its cell in the tree it inhabits, is marked. Abdominal segments 3–7 are free in ♂, and on 3 to 6 is a row of spines at each end; on segments 7 and 8 there are four transverse rows of stout spines, and on 9 two rows of small spines. There is no cremaster. On the under side of segment 8 is a row of about 15 stout spines. Vestiges of three pairs of abdominal legs are distinct. The pupa is provided on the abdomen segments with a few long setæ.

The pupa of Phassus (Fig. 8) is remarkable. The larva bores into a very hard tree, according to the late Mr. Henry Edwards, who kindly gave me a specimen of the pupa. The head is remarkably adapted for its life in a cell, being broad, obliquely truncated, the small antennæ being protected by the flaring sides of the head, which is very solid, with numerous rugosities and small tubercles. The region about the mouth is remarkable. The clypeus and labrum are very narrow, the eye transversely elongated, with an impressed line in the middle. The eye-collar (*mx. p*) is distinctly separated from the maxillæ (*mx*).

The two pieces (*l p*) at the base of the maxillæ may possibly prove to be the labial palpi, if so, is the piece marked *l* the labium? The two paraclypeal pieces or tubercles (*p.*) appear to be the homologue of those in the Psychidæ.

The pupæ of this family are very extraordinary, but it will be seen that they are Pupæ incompletæ, and prove that the

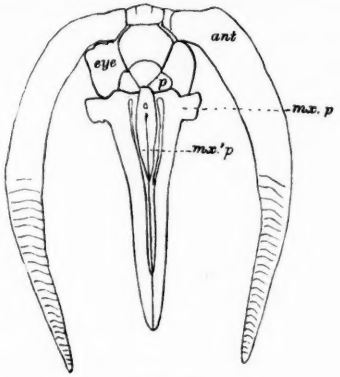


FIG. 9.

family should stand much above the Micropterygidæ, rather than below them, so far as regards pupal characters.

Fig. 9 shows the front of the head and maxillæ of the Cossid, *Prionoxystus robiniæ*, which is more Tortricid than Hepialid; *pc*, paraclypeal piece; *mx. p*, maxillary palpi; *l*, labial palpi; *mx*, maxillæ.

The very primitive, generalized shape of the thorax of the Hepialidæ is noteworthy. In *Hepialus mustelinus* the collar or prothorax is very much reduced; while in *H. tacomæ* it is very long and generalized, as in Sthenopis and the Australian *Abantiades argenteus*. The mesoscutum is considerably shorter than in *H. tacomæ*. In the latter species the metascutum is entirely divided by the large scutellum, while in *H. mustelinus* it is only partly divided, the apex of the scutellum passing a little beyond the middle of the scutum.

It is thus quite evident that Sthenopis is an earlier form than *H. tacomæ*, and that the latter is more generalized, having undergone less modification than *H. mustelinus*.

The genus Hepialus occurs in Australia, and that continent appears to be the original home of the family. In *Abantiades argenteus* the antennæ are tripectinate, and the labial palpi are very large; in *Hectomanes fusca* the antennæ are bi-pectinated but the labial palpi are much reduced, being scarcely visible; while *Oncopera intricata* is remarkably modified; though the antennæ are simple, the eyes are very large, nearly meeting on the front, while the 3-jointed labial palpi are remarkably long and slender, extending upwards, and the hind legs have a remarkable broad, flattened, curved pencil of hairs.

It thus appears that in the Australian continent this interesting family, which may be a survival of Jurassic times and coeval with the marsupials, has branched out along several lines of specialization, the most degenerate form being Hepialus which has survived also in Europe and in North America, especially on the Pacific Coast. On the whole, however,

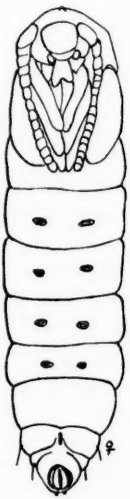


FIG. 10.

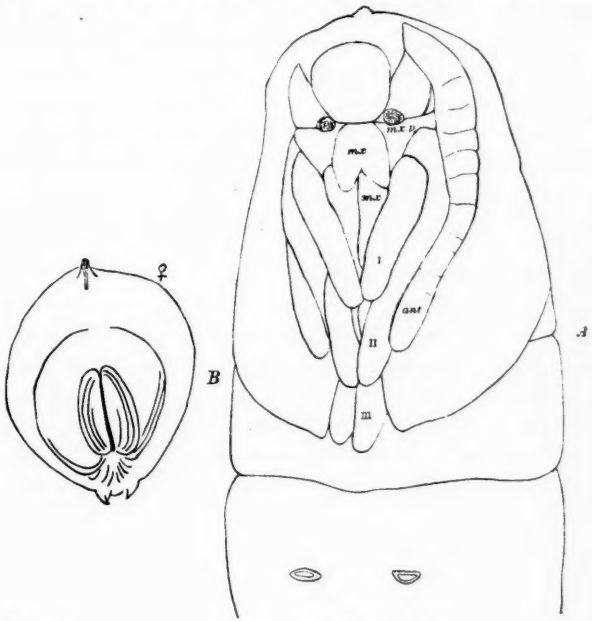


FIG. 10 A.

as we have seen, it is not so generalized a group as the Micropterygidæ, a group common to Europe and North America.

Its relations to the Cossidæ, including the Zeuzerinæ, remain still to be elaborated; they are rather close, yet the Tortricoid affinities are very apparent, and need further examination. The pupa of *Zeuzera pyrina* is of the same character as in Prionoxystus, but the maxillary palpi are larger, the lateral palpi more reduced, while the cell-breaker is very long, being much more developed.

Family Talæporidæ.—This group, comprising the genera Solenobia and Talæporia, have evidently either directly descended from the case-bearing Tineidæ or the two families have had a common origin. They form a side branch by themselves and are evidently the immediate ancestors of the Psychidæ. The imagines have no maxillary palpi, and the tongue is wanting, whilst the females are wingless. They are tineid Bombyces. In the pupal characters (Fig. 10, *Talæporia pseudobombycella*, pupa, A, head enlarged; B, end of body) the group very closely resembles the Psychidæ. Perhaps the slight changes in venation and the much greater breadth of the wings, as well as the pectinated antennæ of the Psychidæ, are the result of adaptation to the stationary mode of life of the females (Fig. 11, *Solenobia walshella*, head of pupa; A, end of body).

Family Psychidæ.—An examination of the pupæ of several genera of this family, convinces me that it belongs among the Tineoids, and that Chapman and also Comstock have rightly removed them from the Bombyces. I should place them in the neighborhood of the Tineoid genera Solenobia and especially Talæporia, the venation of the latter genus being, as shown by the figures in Spuler's[4] paper, almost identical with that of Fumea and Psyche. Without, at this time, referring to the larva of the highly modified wingless female, or to the characters of the adult male, I will simply call attention to some points in the structure of the pupa of different genera of the group, which indicate their very generalized nature.

The pupa of *Thyridopteryx ephemeræformis* has a close resemblance to that of *Oncopera intricata*, as will be seen by the presence of a large median piece or area between the base of the

maxillary palpi. In *Œceticus abbotii* (Fig 12) the maxillary palpi are separated by the second maxillary (labial) palpi; the former (*mx p*) is subdivided into an inner and an outer small lobe in another European Psyche; also in *Platœceticus gloverii*. In the Psychidæ the paraclypeal pieces or tubercles, as we

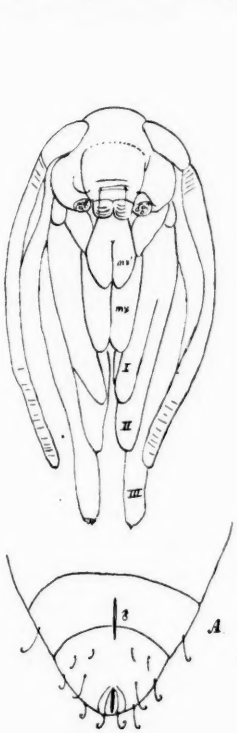


FIG. 11.

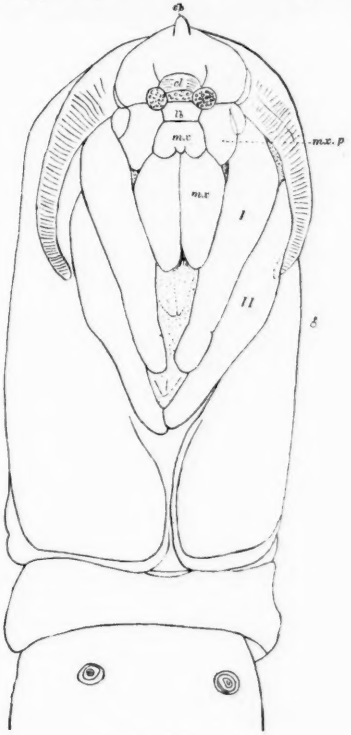


FIG. 12.

might call them, are always present. They are convex and very rugose. The labium or second maxillary piece in the Australian *Eumetopa ignobilis* is of the same shape and sculpturing as in *Psyche graminella*, but the large round rugose pieces on each side, or first maxillary palpi, are single, not divided into two parts, unless the irregularly trapezoidal pieces between the maxillary palpi and the eye-piece be the homologue of the outer portion.

In the Australian *Metura elongata* the short reduced labial palpi are much as in *Psyche graminella*, but are more deeply divided; the two divisions or lobes I am inclined to consider as the second maxillary (labial) palpi. In this genus the first maxillary palpi are also as in *Psyche graminella*.

It will thus be seen that in the pupa of this family the first and second maxillary palpi vary very much in form, as they probably do in the imagines, being more or less atrophied in the latter, where they need to be carefully examined. On the other hand, the maxillæ themselves (for in their pupal condition in haustellate Lepidoptera they have retained the separated condition of the laciniate Lepidoptera) though short are quite persistent in form. The pupa of *Platœceticus gloverii* differs from that of *Œceticus abbotii* in the undivided first maxillary palpus (eye-piece), and the elongated second maxillæ, as well as the narrower clypeal region, and the lack of a cocoon or case-opener.

By an examination of the figures it will be seen that the outer division of the eye-piece varies much in size; this is due to the varying width of the male antennæ, which, when wide, as in Pinara (Entometa), Metrua, Thyridopteryx and Psyche, overlap and nearly conceal it, while it is entirely hidden in Platœceticus. On the other hand in male pupæ of Hepialus and Oncopera, where the antennæ are small, narrow and not pectinated, these pieces are large. The end of the body has no cremaster, but what is unique, a hook arising from each vestigial anal leg.

Finally it will be readily seen that from an examination of the pupæ, the views of Speyer, of Chapman, and of Comstock, as to the position of the Psychidæ is fully confirmed, while I should go a little further and place them still nearer the Hepialidæ. They are, however, still more modified than this last named group, since the females are wingless and limbless. It is very plain that they are an offshoot from the Tineoids, and especially from the Talæporidæ which have no tongue and whose females are wingless and sackbearers.

Remarks on the Cochliopodidæ.—Chapman removes this group from the Bombyces from a study of their larval and pupal char-

acters. We should, after studying the pupæ of five or six genera, agree with his suggestion that this and the family Megalopygidæ (Lagoidæ) should be removed from the Bombyces and placed near the Tineoids, from which they have undoubtedly descended. That the line of descent, however, was directly from the Eriocephalidæ seems to us a matter of doubt. The larvæ of the Cochliopodids present some notable differences from that of Eriocephala, whose so-called "eight pairs of abdominal legs" appear to be merely spine-bearing tubercles. Although the head of Eriocephala is partially retractile, this adaptation may have no phylogenetic significance.

Figure 13 represents the front of the head of *Parasa chloris*, showing the maxillary palpi and a lateral process connected with it, which I have not seen in any other pupæ, and may be internal. I have also observed it in the cast pupal skin of *Tortricidia testacea*. The maxillæ are either shorter or no longer than the large labial palpi. The paraclypeal tubercles are well developed in this group.

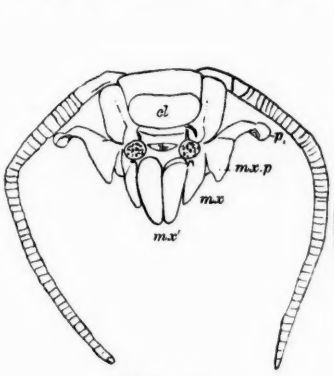


FIG. 13.

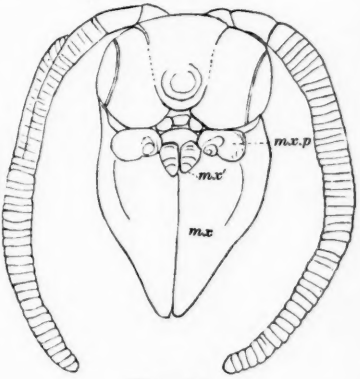


FIG. 14.

Remarks on the Megalopygidæ.—The genus Megalopyge (Lagoa) is remarkable for the shape of the pupa, which is somewhat as in Cochliopodidæ, confirming the view that the two families are allied, though still presenting some notable differences in larval characters. Figure 14 represents the pupal features as seen in the front of the head of a Megalopyge from

Florida (probably *M. crispata* or *opercularis*). The maxillæ seem to be aborted; on each side of the 2d maxillary (labial) palpi under the eye, are the 1st maxillary palpi, whose structure needs farther examination.

The last division of Lepidoptera (*Pupae obtectæ* of Chapman) mostly comprises the specialized broad-winged modern or macropterous forms, though including many of the specialized Tineina.

The next series of families begins with the *Tortricidæ*, from which may have descended the Cossidæ. As will be seen by comparing the pupa of *Tortrix rileyana* with that of the Cossidæ (fig. 9, head and mouth parts of the pupa of *Prionoxystus robiniæ*) Dr. Chapman's opinion that Cossus has "no characters at any stage to distinguish it from Tortrices," is well sustained. The pupal characters of *Zeuzera pyrina* also show that it belongs to the same family as Cossus and its allies. In the Cossidæ there is no separate pupal maxillary palpi, the lateral flap (*mx. p.*) not being separate. The labium and its palpi are long and narrow, as in Tortrix. The paraclypeal pieces are distinct.

The point of departure of Tortrididæ from the Tineina has still to be worked out; it must have been some generalized genus in the pupa of which the eye-collar (maxillary palpi) and labial palpi were well developed.

Here might be placed the two families Thyrididæ and Sessiidæ. After a reconsideration of the transformations of these groups, we agree with Dr. Chapman that as regards the latter "it is a 'Tineoid' in spite of some Tortricid characters." We should, however, not absolutely place the family in the Tineina, but should rather regard it as an immediate descendant from some Tineoid genus with a well developed eye-collar and with a well developed labium. Its generalized nature is also shown in the large distinct paraclypeal pieces. The two families have evidently directly descended from some Tineoid, but they have become much modified and specialized, especially in the venation, and form a side branch of the Tineoid series with absolutely no relation to the Sphingidæ, near which they are usually placed. We have been unable to obtain the pupa of Thyris for examination.

Family Zygænidæ.—Another group supposed by Spuler[4] (venation) and also Chapman (pupa) to be closely related to the Tineoids is the Zygænidæ, from which I should separate the Syntomidæ. The pupa of Zygæna is said by Dr. Chapman to possess "ill-developed eye-collars (maxillary palpi)," and the dehiscence is typically incomplete. I have been unable in the specimen kindly given me by Dr. Chapman to detect the ill-developed eye-collar, but the cast pupa skins examined are not well preserved, and these pieces may be detected in living or alcoholic specimens. Comstock places the Zygænina high up remote from the Tineina, but at present I am disposed to regard the Syntomidæ as a distinct group with a different origin, and more nearly related to the Arctiidæ. I fully agree with Chapman that Zygæna is near the Tineina; and I agree with Comstock that Triprocis and Pyromorpha have "a remarkably generalized condition of wing-structure."

The true Zygænidæ form a side branch or somewhat parallel group. I should regard Ino (Triprocis) as a more generalized genus than Zygæna. Judging by the venation, Harrisina has undergone a little more modification than Ino. Pyromorpha also seems rather more primitive than Zygæna. I see no reason for regarding Pyromorpha as the type of a distinct family.

I have only the pupæ of *Harrisina americana* and of Zygæna to examine, but judging by this scanty material, that of Harrisina seems to be the more generalized form, that of Zygæna the more specialized. As Zygæna does not occur in America, but is Eurasian, it is possible that in its generalized Zygænid fauna America, as in other groups of animals, has lagged behind Europe, Zygæna with its numerous species being a more advanced or specialized type brought into existence by more favorable conditions.

Origin of the Lithosiidæ.—It seems to me that the group of forms usually referred to the Lithosiidæ but which are nearest to the Tineina, is that represented by Enæmia (Eustixia, Mieza), Oeta and Tantura (Penthetria) as the imagines of these

[4] Zur Phylogenie und Ontogenie des Flügelgeaders der Schmetterlinge. Zeits. wissens. Zoologie, 1892.

genera, whether we consider the shape of the head and body, antennæ and legs, or the venation and shape of the wings, are the nearest to the Tineidæ and appear to form a family of Tineoid moths. Indeed Enæmia is now referred to the Tineina of the family Hyponomeutidæ, and possibly the Lithosiidæ originated from this family or from a group standing between them and the Prodoxidæ.

The pupæ have the long narrow head and eyes of Tineina. The eye-collar is wanting, but vestiges of the labial palpi are present, and also vestiges of the paraclypeal pieces. Judging by the venation, Enæmia is the more generalized, and Tantura the more modified genus. The pupa of *Oeta aurea* (fig. 15) in the head characters is rather more generalized than that of Tantura, the labial palpi being a little larger and the base of the maxilla more flaring, as if forming rudimentary eye-collars or palpi, but the abdomen and its end is much more specialized than in Tantura, as it is long, slender, conical, and ends in a well developed cremaster provided with curved setæ adapting it for retaining its hold in its slight cocoon. In general appearance and markings it is like a Geometrid pupa, having black longitudinal stripes. In the pupa of Tantura the shape of the abdomen is more generalized, there being no cremaster, but hooked setæ enabling it to retain its hold within its beautiful loose, basket-like cocoon.

It is probable that these genera descended from some broad-winged Tineid and possibly from the same stem-form as the Prodoxidæ, as the venation is somewhat similar. Hyponomeuta and especially Argyresthia appear to be later, more specialized forms. This group (Enæmia, Oeta, and Tantura) almost directly intergrades, judging from the venation, with the Lithosiidæ, Byssophaga, Cisthene, and Crocota, connecting them with Lithosia; though the larvæ of the latter are much more specialized and arctiiform. Hence the line of descent from the generalized Tineina to Enæmia, Oeta, Tantura, to the Lithosiidæ, and from them to the Arctiidæ, is more or less direct. It is interesting to note the gradual widening of the wings, especially the fore-wings, as we pass from Lithosia to Arctia, also to notice the gradual change in the larval and

pupal characters, those of the Arctian pupæ being slightly less primitive than in the more generalized Lithosiidæ. It is also interesting to note that in ascending from the Tineoid pre-

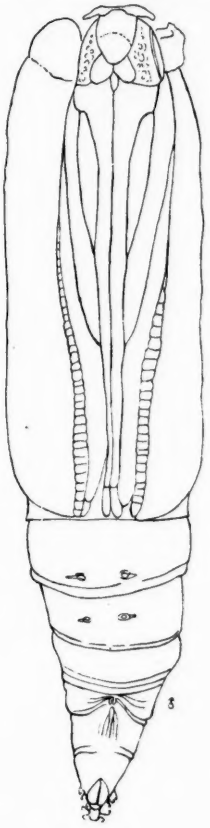


FIG. 15.

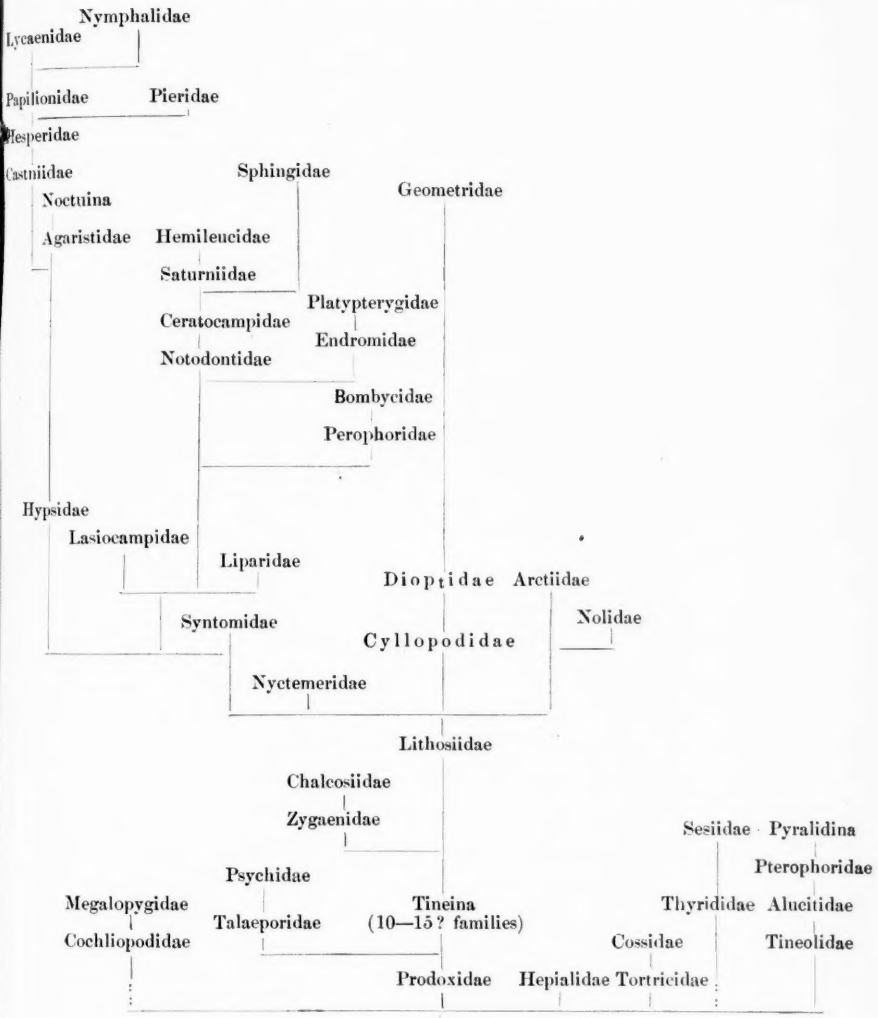
cursors of the Lithosiidæ to the members of the latter family, we pass from incomplete to complete pupæ showing that the division into pupæ incompletæ and obtectæ may be at times artificial.

Family Nolidæ.—The structure of the pupa of Nola (*N. ovilla*), besides its larval and adult characters, convinces me

that the genus is the type of a distinct family, and forming a line of descent somewhat parallel with and near to the Lithosiidæ. The pupa has the labial palpi well developed, and the paraclypeal pieces large. The end of the abdomen is rounded and unarmed, in adaptation to its enclosure in a dense cocoon.

Family Syntomidæ.—The position of the Syntomidæ is difficult to determine. The pupa is obtected, though it has in Scepsis retained the labial palpi. Judging by the larval and pupal characters the family stands much nearer the Arctiidæ than the Zygænidæ, but yet is more generalized than the former. In the venation the group stands near the Arctians, i. e., the venation of the generalized *Ctenucha* approximates that of *Epicallia virginalis*, while in Didasys and Syntomis the venation is more aberrant and modified; so also in the long tufted larvæ of Syntomis and Cosmosoma, compared with that of Ctenucha, in which the tufts are less developed and specialized.

On the following page is a provisional genealogical tree of the order, based mainly on the pupal and imaginal characters.



2. Neolepidoptera (Pupæ incompletæ and Pupæ obtectæ).

1. Palaeolepidoptera (Pupae liberæ. *Micropterygidæ*).

Suborder II. Lepidoptera haustellata.

Suborder I. Lepidoptera laciniata (Protolepidoptera. *Eriocephalidæ*).

DEVIATION IN DEVELOPMENT DUE TO THE USE OF UNRIPE SEEDS.[1]

By J. C. Arthur.

There is something surprising in the degree of immaturity at which seeds will grow. The usual opinion is, I believe, that seeds not fully ripe will be shrunken and light, and quite worthless for sowing. To some extent there is truth in this, and yet seeds will vegetate when taken from fruit not half grown, and in which the pulp and even the seeds themselves have the color of fresh, green leaves. Plants from such seeds may flourish, bloom and fruit, and with a certain moderate amount of deviation, show all the usual phases of existence incident to the particular kind of plant life.

This is by no means a recent discovery, but was known to Theophrastus,[2] as early as the third century before Christ, who expressed his surprise at the fact, and says that it is wonderful that unripe, imperfect seeds should be able to grow. The fact was established experimentally, however, by several early investigators, notably by Duhamel,[3] in 1760, using flowering ash and walnut, by Senebier,[4] in 1800, using peas, and by Lefebure,[5] in 1801, using radish. In 1822 a successful trial with green seed was made by Seyffer,[6] of Stuttgart, which has attracted much attention. The Japanese Sophora, although growing to be a fine tree in Germany, does not often set fruit, and never ripens any, at least in Würtemberg, on account of the cool summers. Despairing of ever securing ripe seed from which to propagate the tree, Seyffer took a branch bearing green fruit, not yet half full size, hung it up until dry, then removed and planted the seed in a cold frame. In this way he obtained 500

[1] Read before the section of botany of the A. A. A. S., Madison meeting, August, 1893.

[2] De causis plantarum, lib. iv., cap. 4.

[3] Duhamel du Monceau, Des semis et plantation des arbres, p. 83.

[4] Senebier, Phys. végétale, iii, p. 377.

[5] Lefebure, Expériences sur la germination des plantes, p. 27.

[6] Seyffer, Isis, 1838, p. 113.

young plants, many of which still were to be seen as handsome trees in the grounds of the forestry school at Hohenheim, and in the vicinity, sixteen years afterward, when the paper from which we quoted was read. The economic importance of such a procedure, and its applicability to numerous contingencies, has brought the incident much well merited attention.

It would be possible to cite many other instances[7] of the successful germination of green seed, but it is unnecessary, for all doubt regarding the viability of such seed was set at rest long ago in the very exhaustive treatise upon the subject by Ferdinand Cohn, entitled, "Symbola ad seminis physiologiam," 1847, in which he not only reviewed the previous history, but

[7] Waitz, with morning glory (Convolvulus Nil) Bot Zeit, 1835, p. 5.

Kunze, with wheat. Bot Zeit., 1835, p. 5.

Kurr, with rye (?), ten-weeks-stock Bot Zeit., xviii (1835), p. 4.

Seyffer, with peas, kidney beans (Phaseolus vulgaris), English beans (Vicia Faba), soja beans, lentils, laburnum, Sophora Japonica. Bot. Zeit., 1836, p. 84; Isis, 1838, p. 5

Treviranus, with turnips and peas. Physiologie der Gewächse, ii (1838), p. 576.

Göppert, with rye. Bot. Zeit., v (1847). p. 386.

Cohn, with beans (Phaseolus vulgaris), lupines, radish, shepherd's purse, corn, sorghum, datura, apple, cucumber, canna, evening primrose, princes' feather (Amarantus caudatus), morning glory, (Ipomœa purpurea), Salvia verbascifolia, pinks, squirting cucumber (Momordica Elaterium), bladder senna Colutea arborescens), marshmallow (Althæa officinalis), castor bean. Symbola ad seminis physiologiam, 1847; Flora, xxxii (1849), p. 481.

Lucanus, with rye. Landw. Vers.-St., iv (1860), p. 262.

Siegert, with wheat. Landw. Vers.-St, vi (1863), p. 134.

Nowacke, with wheat. Untersuchungen über das Reifen des Getreides, 1869, p. 37.

Nobbe, with spruce (Picea vulgaris). Tharander forstl. Jahrbuch, xxiv (1874), p. 203; Landw. Vers.-St, xvii (1876), p. 277; Handbuch der Samenkunde, 1876; p. 338.

Sagot, with wheat (?). Arch. des. Sci. Phys. et Nat, 1876; Just's Bot. Jahresb., iv, p. 1243.

Tautphöus, with rye. Ueber die Keimung der Samen, 1876, p. 23

Wollny, with winter rye. Forsch. Geb. Agrik.-Phys., ix (1886), p. 294.

Sturtevant, with maize. Rep., N. Y. Exper. Sta, ii (1883), p. 39.

Goff, with tomatoes, peas, turnips, lettuce. Rep. N. Y. Exper. Sta., ii (1883), p. 205; iii (1884), pp. 199, 211, 224, 232; iv (1885), pp. 130, 182; v (1886), p. 174, 197.

Atwell, with morning glory (Ipomœa purpurea). Bot. Gaz., xv (1890), p. 46; Bot. Centr., xlvi (1891), p. 162.

Bailey, with tomato. Bull. Cornell Exper. Station, No. 45. 1892, p. 207.

also himself grew plants of more than a score of widely diverse species from seed in various stages of immaturity.

At the very beginning of the agitation of the subject, a curious misusage in terminology arose, which at one time led to considerable controversy, but which gradually disappeared with the better elucidation of the subject. The confusion was in regard to the application of the terms viability, or power of germination, and maturity, or ripeness. The implied reasoning of most writers, especially the earlier ones, seems to have been this: The object of maturity is to render the seed capable of becoming an independent plant through germination, therefore a seed must be mature before it can germinate, *per contra*, the seed that germinates has already reached maturity.

In Gærtner's monumental work on seeds and fruits, published in 1790, is the statement[8] that seeds are ripe as soon as they can germinate, although from their color, weight and size, they may not appear so. Senebier,[9] in the year 1800, held that seeds must be ripe in order to grow, and yet at the same time says that he has seen green tender peas, taken from equally green pods, germinate. The same confusion of ideas is shown in the defense which Keith made when DeCandolle[10] pointed out that it was an error to place maturity of the seed as one of the conditions for germination, as Keith[11] had done in his work on vegetable physiology, published in 1816. Keith[12] says: "The seed that will germinate is, physiologically speaking,

[8] "Semen maturum, ut docet, non ex colore suo saturato, nec ex sua in aqua subsidentia, neque etiam ex duritie sua satis tuto cognoscitur; sed certior maturitatis nota ex ipso trahenda est nucleo; quippe que, si ex gelatinosa sensim factus sit solidiusculus, si testæ suæ cavitatem repleat exactissime, atque si intra se ipsum nullum prorsus contineat spatium vacuum, indubitatissimum præbit seminis maturi signum quia ita conformatum, germinando aptum est, quæcunque etiam fuerit reliqua ejus conditio." Gærtner, De fructibus et seminibus plantarum, ii (1790), I, p. cxii.

[9] "Les graines doivent être mûres pour germer; pour l'ordinaire elles ne germent pas quand on les a cuillies avant leur maturite; j'ai pourtant vu germer des pois verts and tendres otes de leurs siliques vertes and molles." Senebier, l. c. iii, p. 377.

[10] Phys. Veg., ii (1832), p 662.

[11] Keith, System of vegetable physiology, ii (1816), p. 3.

[12] Phil. Mag., viii (1836), p. 492.

ripe; that is, its fluids have been so elaborated in the process of its maturation, and its solids so vitalized in the assimilation of due aliment as to be now fully and profitably susceptible of the action of the combined stimuli of the soil and atmosphere. Hence I contend, notwithstanding the objection of M. DeCandolle, that the maturity of the seed is rightly and legitimately placed in the list of the conditions of germination." Treviranus[13] held essentially the same views, and expressed himself quite as strongly in his work on vegetable physiology, about the same time. Even Cohn, in his clear and scholarly paper, did not quite set the matter straight. He came to the conclusion,[14] that although the proper ripening of the seed is dependent upon the parent plant, yet when prematurely separated it will still pass through the ripening stage before germinating; there is thus an after-ripening for green seeds, which fits them for continued growth. Although he seemingly held that seeds cannot germinate until they in some way ripen, yet he asserted (and it is a most important deduction, correctly worded) that viability does not usually coincide with maturity, but precedes it.[15]

Since the time of Cohn the terminology adopted has agreed well with the facts. The present usage is presented in Nobbe's large and excellent treatise upon seeds. He says:[16] "The continued life of the embryo is not dependent upon the completion of the storing of reserve material in the seed; the power of germination appears much earlier, even in a stage of development of the seed undoubtedly to be designated as 'unripe.'

[13] "Zum keimen gehort, dass der Same reif sei; das heisst, das der Embryo in dem Grade entwickelt sei, dass er von der Mutterpflanze getrennt, unter Aneignung des Vorrathes nährender Materie im Perisperm oder, in den Samenlappen für sich fortleben kann." Treviranus, l. c., ii, p. 574.

[14] Quum maturatio seminis propria non afficiatur a planta, sumendum videtur, ut etiam processura sit, semine soluto a planta; vel, ut postmaturari possint semina. Cohn, l. c, p. 72.

[15] Facultas germinandi non in idem tempus coincidere solet cum maturitate; hanc illa præcedit Cohn, l. c., p 73.

[16] Die Lebensfähigkeit des Embryo ist an die Vollendung der Reservestoff-Aufspeicherung in Samen nicht gebunden. Die Keimfähigkeit tritt weit früher, schon in einem unzweifelhaft als "unreif" zu bezeichnenden Entwicklungsstadium des Samen ein. Nobbe, Samenkunde, p. 339.

Wiesner[17] has given a concise definition. "The condition," he says, "in which a seed loosens itself from the plant in order to continue its development independently, is designated as maturity." We are, therefore, to regard maturity as applying to the seed as a whole, and viability as applying to the embryo, the physiological processes associated therewith being quite distinct. After-ripening, which takes place when partly grown seed is separated from the parent plant, only leads to partial maturity.

It is an inquiry full of interest as to the minimum development at which a seed will germinate. Goff,[18] in 1884, planted tomato seed in March in boxes in the greenhouse, saved the previous season from fruit still thoroughly green, and obtained only 2 per cent of vegetation. But seed from fruit of full size, and which had begun to lose its green color, although not yet showing any tinge of redness, vegetated 84 per cent, while from fruit with a faint reddish tinge the percentage of vegetation reached 100. In another experiment he found[19] that peas planted in the usual manner in the open ground in April, that had been gathered when in the condition best suited to table use, gave only 3 per cent of vegetation, while those just past this stage of edible maturity gave 9 per cent. But in all probability the conditions of growth at the time were not particularly favorable, as fully ripe seed in the same experiment gave only 54 per cent. of vegetation. In a very carefully conducted experiment with wheat made by Nowacki, selected seed saved from grain when in the milk gave 92 per cent of vegetation, and from grain when turning yellow, as well as when fully ripe, gave 100 per cent., the seed being sown in the open ground (see table III.) Nobbe[20] found that seed of Spruce (*Picea vulgaris* Lk.) gathered on the first and fifteenth of each month from the middle of July to the first of November, and tested in the laboratory in the following January, gave increased

[17] Der Zustand, in welchem ein Same sich von der Pflanze loslöst, um sich selbständig weiterzuentwickeln, wird als Reife bezeichnet. Wiesner, Biologie der Pflanzen, 1889, p. 40.

[18] L. c., iii, p. 224.

[19] L. c., iii, p. 232.

[20] L. c.

percentage of germination according to degree of maturity (see table I). In experiments performed by myself in 1889 to-

I.—Germination of Spruce Seeds at Different Stages of Maturity.

Experiment conducted by Nobbe.

Spruce seed, gathered July 15, gave	0 per cent germinations.
Spruce seed, gathered Aug. 1, gave	40.8 per cent germinations.
Spruce seed, gathered Aug. 15, gave	61.2 per cent germinations.
Spruce seed, gathered Sept. 1, gave	75.3 per cent germinations.
Spruce seed, gathered Sept. 15, gave	71.6 per cent germinations.
Sprnce seed, gathered Oct. 1, gave	84 5 per cent germinations.
Spruce seed, gathered Nov. 1, gave	88.2 per cent germinations.

mato seed from green and ripe fruit of the previous season, tested in April in the laboratory, gave 60 per cent germination for the immature seed against 100 per cent for the fully mature. Considerable other data are on record, all going to show that seeds are more certain to germinate the nearer they approach to maturity, or conversely, the more immature the seed, the less number of chances for its germination.

The internal examination of the seed to determine the actual stage of development, in connection with such studies, has been rarely attempted. Seyffert and Cohn agree, however, that with such seeds as peas, beans, lentils, canna and evening primrose, the embryo must be sufficiently formed to be detected with a hand lens, in order that the seed should be capable of growth. If the embryo is watery and unformed, according to these observers, the seed will not germinate.

Probably most of us would at first think, as Cohn[21] did, that "it is a curious circumstance in this connection, that while in the ripening of the seed innumerable stages are run through, passing one into the other without interruption, in germination, which is as it were a function of maturity, no transition exists. For evidently a seed can only either germinate or not

[21] Es zeigt sich hierbei der eigenthümliche Umstand, dass während bei der Reife der Same unzählige, ohne Unterbrechung in einander übergehende Stufen durchläuft, bei der Keimfähigkeit. die gleichsam Function der Reife ist; kein Uebergang existirt. Denn offenbar kann ein Same nur entweder keimen, oder nicht; ein drittes giebt es nicht. Cohn, Flora, xxxii (1849), p. 500.

germinate; there can be no third course." But this is very fallacious reasoning, and is founded upon a misunderstanding of the nature of the seed. In the first place germination is not, even constructively, a function of maturity, as it readily occurs both before and after maturity. From our present standpoint, in whatever way the earlier writers may have viewed the matter, a seed is simply a young plant enclosed in a protective covering derived from the parent plant, and accompanied by surplus nutriment. The resting condition of a seed is purely incidental and designed to aid in distribution and in guarding the plant against injury while very young. From the time of the first cell division in the forming embryo until the new individual becomes established as a free growing plant, there need be no check in the continuous growth, except through untoward conditions, or inherent tendency to provide for such conditions. The germination of seeds inside the fruit of oranges, and gourds, and the ready growth of the mangrove, are familiar instances where the resting period has been practically evaded, and development of the plantlet has been nearly or quite continuous

In the growth of green seed we have a case where an attempt is made to give the plantlet the conditions for continued development without passing through the full protective stage. There is nothing in the nature of things, except the want of skill, to prevent the plantlet being removed from the parent plant at any point in its early development, even before its organs can be detected, and by supplying it with the necessary nutriment, heat and moisture, and protecting it against the inroads of destructive organisms (bacteria, molds, etc.), securing to it by these artificial means the conditions for uninterrupted growth, with the entire omission of the usual resting stage.

With this view of the subject it is easy to explain why green seed generally gives fewer germinations as a rule than mature seed; the more exacting conditions for its growth are not well met. And, further, it is evident that Cohn's aphorism that a seed can only germinate or not germinate is saying that a seed can continue to grow or not continue to grow, and is thus robbed of all its mysticism.

To fully understand the problem before us it will be well to inquire into the meaning of maturity. In the course of normal development of the seed the testa becomes more firm and less permeable, the organic constituents of the cells are transformed into solids or semi-solids, there is a loss of water, growth finally ceases, the organic connection with the parent plant is severed, and the seed is ripe. It remains in an inactive, dormant condition a longer or shorter time and then germinates. Maturity is reached in this metamorphosis when the protecting testa, or pericarp, as the case may be, has become sufficiently solid, and the inner parts sufficiently advanced to permit separation from the parent plant without endangering the life of the embryo.

A most curious thing in connection herewith is the fact that the seed, and sometimes the associated parts of the fruit, will continue to develop under circumstances which put a stop to all growth in the vegetative parts of the plant. If a branch is severed from a tree, all growth in its buds and leaves ceases at once, it wilts, and shortly dies. But the fruits and seeds attached to it continue to develop, and will so continue as long as sufficient moisture remains to transport what food material exists, from the leaves and stem into the fruit and seed. This process is known as after-ripening. So far as I know, it has not been intimately investigated, but I am inclined to think that during this process the embryo continues in actual growth, forming new cells, and elaborating its organs, but that little or no growth takes place in the surrounding parts, although great chemical changes and accumulation of substances do occur.

It was observed by Cohn,[22] who was the first to note such phenomena, that green seeds entirely removed from the fruit and laid in moist earth or sand passed through the various changes of color of normal ripening. If very young, they did not progress far, but if sufficiently grown, although still perfectly green in color, they underwent the intermediate changes, and finally gave every appearance of full, mature seeds. He experimented with the seeds of apple, pear, beans, lupines, Amarantus caudatus, Polygonum tartaricum, Colutea arbor-

[22] Symbola, pp. 67-70; Flora, pp. 508-510.

escens, Kœlreuteria paniculata, and Canna orientalis. An experiment in after-ripening by Lucanus,[23] is very instructive (see table II). He gathered rye in five stages of maturity, ranging from very small kernels, not yet milky, up to fully ripe kernels. Each collection was separated into four lots; in the first the kernels were removed from the heads at once, in the second, they were allowed to remain in the heads, but the

II.—Weight of 1000 Air-Dry Kernels of Rye at Different Stages of Maturity.

Experiment conducted by Lucanus.

Weight of 1000 air dry kernels, in grams.	I. Gathered June 28. Grain very small, soft and green.	II. Gathered July 3. Grain becoming milky.	III. Gathered July 10. Juices thick and milky.	IV. Gathered July 18. Grain solid, straw yellow.	V. Gathered July 26. Fully ripe.
Kernels removed at once...	10430	14655	18366	20294	22230
Left in the separated heads..	10575	14830	18510	20302	22250
Left on cut plant.....	11310	14930	18620	20302	22280
Roots in distilled water...	13790	15440	20220	21070	22325

heads were removed from the stalks; in the third they remained attached to the plant which was cut near the ground, and in the fourth the plants were pulled, the roots washed, and set in distilled water. A thousand air-dry seeds from each lot were finally weighed. In all cases the grain weighed more when permitted to remain in the head than when removed at once, still more when all the stem and leaves were attached, and very much more when the uprooted plant was supplied with water. After-ripening is thus seen to play a very important part in the handling of immature seed.

There is a state of over-maturity of seeds, which has importance in this connection. It is well known that the life of the

[23] L. c.

seed is limited; some seeds will not grow after a few weeks or months, although most seeds are good for from one to several years. In all cases the seed gradually loses its vitality, and sooner or later ceases to live, unless in the mean time given the means for germination.

In view of these facts we can better appreciate the importance of the discovery made by Cohn[24] that there is an optimum for most rapid germination which falls, as a rule, just before obvious maturity, (or possibly at the end of the resting stage, where this is very pronounced, a point not yet investigated), and before and after this optimum the germination is slower.

We are thus led to consider the seed as accumulating energy up to the approximate time of its maturity, and then gradually losing this energy so long as it remains an inactive seed; and that the measure of this energy is the vigor of its germination. There is a wealth of data to substantiate this theory of the life of a seed, but which would be burdensome to further present at this time.

Turning now to a more detailed consideration of the deviations from normal development in plants from immature seed, the weakness of the seedlings will be one feature to first attract the attention of the investigator. In a number of trials with green seed of tomatoes, made at various times since 1889, I have found[25] that the young plants are under size; the stems being shorter and cotyledons smaller. They have less strength, and in consequence many perish in the vain attempt to lift the covering of soil. Some are unable to extricate the cotyledons from the ruptured testa, and often perish from this cause, even after having reached the light. If the seeds are germinated between folds of moist cloth or bibulous paper, such miscarriage will show even more clearly. Similar effects were observed by Cohn, in the use of canna seed. He says:[26] "All plants ob-

[24] Ich selbst habe bei Canna, Œnothera, Lupinen und anderen ein mittleres Stadium im Reifungsprocesse beobachtet, in dem die Samen sich am schnellsten entwickelten; von da aufwärts und abwärts die reifen und die weniger ausgebildeten schienen mir langsamer zu keimen. Cohn, Flora, xxxii, p. 504.

[25] The data are recorded in the manuscript records of the Indiana Experiment Station, and have not yet been published.

[26] Dagegen waren alle aus den jüngsten Samen gezogenen Pflänchen hinfällig und schwächlich und gediehen kaum über das erste Blatt. Flora, xxxii, p. 501.

tained from the youngest seeds were slender and weak,a nd scarcely progressed beyond the first leaf." Goff,[27] who has made experiments with immature tomato and other seeds at intervals from 1884 to the present time, early noted this characteristic of the seedlings.

The rate of germination is in general slower for immature than for mature seeds. This has been observed by Seyffert, Göppert, Cohn, Toutphöus and others, but this depends upon many internal and external conditions affecting the seed, and it is, therefore, not inconsistent with our theory of the process to find that some observers (Duhamel, Senebier) have noted an increased rate of germination for immature seeds. In an experiment by the writer (manuscript record No. 82) in 1890, tomato plants (24) from the seed of ripe fruit planted in a cold frame, came through the soil in an average of 12 days, plants (5) from seed of half-ripe fruit in 12.2 days, and plants (13) from seed of green fruit in 14.2 days. Other trials with tomato, as well as with peas, wheat, and other kinds, made in the laboratory, using folded cloth, have also given tardy germinations for unripe seeds. Nowacki[28] removed seeds from the heads of wheat when in the milk stage, when turning yellow, and when fully ripe, and sowed carefully selected kernels in the garden (see table III). The rate of germination, judging by the time of appearance of the plants above ground, was much slower for the immature seed, the number on the eleventh day after sowing, being respectively 12, 19, 25.

III.—Wheat from Unripe Seed.

Experiment conducted by Nowacki.

Degree of ripeness.	No. seeds.	Germinations.		Stalks.		
		On 11th day.	Total.	Av. No. per plant.	Av. height in cm.	Product of No. by Ht.
In the milk	50	12	45	4.6	128	589
Turned yellow....	50	19	50	5.4	125	675
Fully ripe.....	50	25	50	5.9	121	714

[27] L. c., iii, p. 225; iv, p. 182.

[28] L. c.

Owing to their weakened condition the plants from immature seed are less able to withstand unfavorable conditions than those from ripe seed, the difference being more marked the younger the seeds. In my own attempts to grow very green tomato seeds in the green-house, fully eighty-five per cent of the plants that had unfolded the cotyledons, perished before reaching the third leaf. Wollny[29] observed a great loss of plants from immature seed of winter rye, taking into account the number of plants growing in the fall and in the following spring, while the plants from ripe seed under the same conditions experienced no loss whatever (see table IV).

IV.—Winter Rye from Ripe and Unripe Seed.

Experiment conducted by Wollny.

Degrees of ripeness.	Number planted.	Growing in fall.	Growing in spring.	Wintered per cent.
Very green	100	97	40	41
In the milk	100	96	88	91
Pale yellow	100	100	100	100
Fully ripe	100	100	100	100

[29] L. c.

(*To be continued.*)

THE EFFECT OF FEMALE SUFFRAGE ON POSTERITY.

By James Weir, Jr.

The greatest, best, and highest law of Higher Civilization is that which declares that men should strive to benefit not himself alone, but his posterity.

I. The Origin of the Matriarchate.

In the very beginning woman was, by function, a mother; by virtue of her surroundings, a house-wife. Man was then,

as now, the active, dominant factor in those affairs outside the immediate pale of the fireside. Life was collective; "communal was the habitation, and communal the wives with the children; the men pursued the same prey, and devoured it together after the manner of wolves; all felt, all thought, all acted in concert." Primitive men were like their Simian ancestors which never paired, and which roamed through the forests in bands and troops. This collectivism is plainly noticeable in certain races of primitive folks which are yet in existence, notably the Autocthons of the Aleutian Islands. Huddled together in their communal *Kachims*, naked, without thought of immodesty, men, women and children share the same fire and eat from the same pot. They recognize no immorality in the fact of the father cohabiting with his daughter —one of them naively remarking to Langsdorf, who reproached him for having committed this crime: "Why not? the otters do it!" Later in life the men and women mate; but even then there is no sanctity in the marriage tie, for the Aleutian will freely offer his wife to the stranger within his gates, and will consider it an insult if he refuses to enjoy her company. "As with many savages and half-civilized people, the man who would not offer his guest the hospitality of the conjugal couch, or the company of his best-looking daughter, would be considered an ill-bred person."

This laxity in sexual relations was, at first, common to all races of primitive men, but, after a time, there arose certain influences which modified, to a certain extent, this free and indiscriminate intercourse. Frequent wars must have occurred between hostile tribes of primitive men, during which, some of them (physically or numerically weaker than their opponents) must have been repeatedly vanquished, and many of their females captured, for, in those old days (like those of more recent times, for that matter) the women were the prizes for which the men fought.

Under circumstances like these, the few remaining women must have served as wives for all the men of the tribe; and, in this manner polyandry had its inception. Polyandry gives woman certain privileges which monandry denies, and

she is not slow to seize on these prerogatives and to use them in the furtherance of her own welfare. Polyandry, originating from any cause whatsoever, will always end in the establishment of a matriarchate, in which the women are either directly or indirectly at the head of the government. There are several matriarchates still extant in the world, and one of the best known, as well as the most advanced, as far as civilization and culture is concerned, is that of the Nairs, a people of India inhabiting that portion of the country lying between Cape Comorin and Mangalore, and the Ghâts and the Indian Ocean. The Nairs are described as being the handsomest people in the world; the men being tall, sinewy, and extraordinary agile, while the women are slender and graceful with perfectly modeled figures. The Nair girl is carefully chaperoned until she arrives at a marriageable age, say, fourteen or fifteen years, at which time some complaisant individual is selected who goes through the marriage ceremony with her. As soon as the groom ties the *tali* or marriage cord about her neck, he is feasted and is then dismissed; the wife must never again speak to or even look at her husband. Once safely wedded, the girl becomes emancipated, and can receive the attentions of as many men as she may elect, though, I am informed, that it is not considered fashionable, at present, to have more than seven husbands, one for each day of the week. Of no importance, heretofore, after her farcical marriage, the Nair woman at once becomes a power in the councils of the nation; as a matter of course, the higher her lovers the higher her rank becomes and the greater her influence. Here is female suffrage in its primitive form, brought about, it is true, by environment, and not by elective franchise. As far as the children are concerned, the power of the mother is absolute; for they know no father, the maternal uncle standing in his stead. Property, both personal and real, is vested in the woman; she is the mistress and the ruler. "The mother reigns and governs; she has her eldest daughter for prime minister in the household, through whom all orders are transmitted to her little world. Formerly, in grand ceremonials, the reigning prince himself yielded precedence to his eldest daughter, and, of course, recognized still

more humbly the priority of his mother, before whom he did not venture to seat himself until she had given him permission. Such was the rule from the palace to the humblest dwelling of a Nair." During the past fifty years, these people have made rapid strides toward civilization, monandry and monogamy taking the place of polyandry and polygamy, and fifty or an hundred years hence, this matriarchate will, in all probability, entirely disappear.

I have demonstrated, I think, clearly and distinctly, that matriarchy or female government, is neither new nor advanced thought, but that it is as old, almost, as the human race; that the "New Woman" was born many thousands of years ago, and that her autotype, in some respects, is to be found to-day in Mangalore. A return to matriarchy at the present time would be distinctly, and emphatically, and essentially retrograde in every particular. The right to vote carries with it the right to hold office, and, if women are granted the privilege of suffrage, they must be given the right to govern. Now let us see if we can not find a reason for this atavistic desire (matriarchy) in the physical and psychical histories of its foremost advocates. I will discuss this question in Part II of this paper.

II. THE VIRAGINT.

There are two kinds of genius; the first is progressive genius, which always enunciates new and original matter of material benefit to the human race and which is consequently healthy; the second is retrogressive genius, which is imitative and which always enunciates dead and obsolete matter long since abandoned and thrown aside as being utterly useless. The doctrines of communism and of nihilism are the products of retrogressive genius and are clearly atavistic, inasmuch as they are a reversion to the mental habitudes of our savage ancestors. The doctrines of the matriarchate are likewise degenerate beliefs, and if held by any civilized being of to-day, are in evidence of psychic atavism. Atavism invariably attacks the weak; and individuals of a neurasthenic type are more frequently its victims than

are any other class of people. Especially is this true in the case of those who suffer from psychical atavism. The woman of to-day, who believes in and inculcates the doctrines of matriarchy, doctrines which have been, as far as the civilized world is concerned, thrown aside and abandoned these many hundred years, is as much the victim of psychic atavism as was Alice Mitchell who slew Freda Ward in Memphis several years ago, and who was justly declared a viragint by the court that tried her. Without entering into the truthfulness or falseness of the theory advanced by me some time ago (vide *N. Y. Medical Record*, September, 1893: "Effemination and Viraginity") in regard to the primal cause of psychic hermaphroditism, which I attributed and do still attribute to psychic atavism, I think that I am perfectly safe in asserting that every woman who has been at all prominent in advancing the cause of equal rights in its entirety, has either given evidences of masculo-feminity (viraginity), or has shown, conclusively, that she was the victim of psycho-sexual aberrancy. Moreover, the histories of every viragint of any note in the history of the world, show that they were either physically or psychically degenerate, or both. Jeanne d'Arc was the victim of hystero-epilepsy, while Catharine the Great was a dipsomaniac and a creature of unbounded and inordinate sensuality. Massalina, the depraved wife of Claudius, a woman of masculine type whose very form embodied and shadowed forth the regnant idea of her mind—absolute and utter rulership—was a woman of such gross carnality that her lecherous conduct shocked even the depraved courtiers of her lewd and salacious court. The side-lights of history, as Douglas Campbell has so cleverly pointed out in his "Puritan in Holland, England and America," declares that there is every reason to believe that the Virgin Queen, Elizabeth of England, was not such a pure and unspotted virgin as her admirers make her out to be. Sir Robert Cecil says of her that "she was more man than woman," while history shows conclusively that she was a pronounced viragint, with a slight tendency toward megalomania. In a recent letter to me, Mr. Geo. H. Yeaman, ex-Minister to Denmard, writes as follows: "Whether it be the relation of cause

and effect, or only what logicians call a "mere coincidence," the fact remains that in Rome, Russia, France and England, political corruption, cruelty of government, sexual immorality —nay, downright, impudent, open, boastful indecency—have culminated, for the most part, in the eras of the influence of viragints on government, or over governors."

Viraginity has many phases. We see a mild form of it in the tom-boy who abandons her dolls and female companions for the marbles and masculine sports of her boy acquaintances. In the loud-talking, long-stepping, slang-using young woman we see another form, while the square-shouldered, stolid, cold, unemotional, unfeminine android (for she has the normal human form, without the normal human *psychos*) is yet another. The most aggravated form of viraginity is that known as homo-sexuality; with this form, however, this paper has nothing to do. Another form of viraginity is technically known as gynandry, and may be defined as follows: A victim of gynandry not only has the feelings and desires of a man, but also the skeletal form, features, voice, etc., so that the individual approaches the opposite sex anthropologically, and in more than a psycho-sexual way (*Krafft-Ebing*). As it is probable that this form of viraginity is sometimes acquired to a certain extent, and that too, very quickly, when a woman is placed among the proper surroundings, I shall give the case of Sarolta, Countess V., one of the most remarkable instances of gynandry on record. If this woman, when a child, had been treated as a girl, she would, in all probability, have gone through life as a woman, for she was born a female in every sense of the word. At a very early age, however, her father, who was an exceedingly eccentric nobleman, dressed her in boy's clothing, called her Sandor, and taught her boyish games and sports.

"Sarolta-Sandor remained under her father's influence till her twelfth year, and then came under the care of her maternal grandmother, in Dresden, by whom, when the masculine play became too obvious, she was placed in an institute and made to wear female attire. At thirteen, she had a love relation with an English girl, to whom she represented herself as a

boy, and ran away with her. She was finally returned to her mother, who could do nothing with her, and was forced to allow her to resume the name of Sandor and to put on boy's clothes. She accompanied her father on long journeys, always as a young gentleman; she became a *roué*, frequenting brothels and *cafés* and often becoming intoxicated. All of her sports were masculine; so were her tastes and so were her desires. She had many love affairs with women, always skillfully hiding the fact that she herself was a woman. She even carried her masquerade so far as to enter into matrimony with the daughter of a distinguished official and to live with her for some time before the imposition was discovered. The woman whom Sandor married is described as being "a girl of incredible simplicity and innocence;" in sooth, she must have been! Notwithstanding this woman's passion for those of her own sex, she distinctly states that in her thirteenth year she experienced normal sexual desire. Her environments, however, had been those of a male instead of a female, consequently her psychical weakness, occasioned by degeneration inherited from an eccentric father, turned her into the gulph of viraginity, from which she at last emerged, a victim of complete gynandry. I have given this instance more prominence than it really deserves, simply because I wish to call attention to the fact that environment is one of the great factors in evolutionary development.

Many women of to-day, who are in favor of female suffrage, are influenced by a single idea; they have some great reform in view, such as the establishment of universal temperance, or the elevation of social morals. Suffrage in its entirety, that suffrage which will give them a share in the government, is not desired by them; they do not belong to the class of viragints, unsexed individuals, whose main object is the establishment of a matriarchate. Woman is a creature of the emotions, of impulses, of sentiment, and of feeling; in her the logical faculty is subordinate. She is influenced by the object immediately in view, and does not hesitate to form a judgment which is based on no other grounds save those of intuition. Logical men look beyond the immediate effects of an action

and predicate its results on posterity. The precepts and recepts which form the concept of equal rights also embody an eject which, though conjectural, is yet capable of clear demonstration, and which declares that the final effect of female suffrage on posterity would be exceedingly harmful.

We have shown, in Part II of this paper, that the pronounced advocates and chief promoters of equal rights are probably viragints—individuals who plainly show that they are psychically abnormal; furthermore, we have seen that the abnormality is occasioned by degeneration, either acquired or inherent, in the individual. Now let us see, if the right of female suffrage were allowed, what effect it would produce on the present environment of the woman of to-day, and, if any, what effect this changed environment would have on the psychical habitudes of the woman of the future. This portion of the subject will be discussed in Part III of this paper.

III. THE DECADENCE.

It is conceded that man completed his cycle of physical development many thousands of years ago. Since his evolution from his pithecoid ancestor, the forces of nature have been at work evolving man's psychical being. Now, man's psychical being is intimately connected with, and dependent on, his physical being, therefore, it follows that degeneration of his physical organism will, necessarily, engender psychical degeneration also. Hence, if I can prove that woman, by leading a life in which her present environments are changed, produces physical degeneration, it will naturally follow that psychical degeneration will also accrue; and, as one of the invariable results of degeneration is atavism, both physical and psychical, the phenomenon of a social revolution, in which the present form of government will be overthrown and matriarchy established in its stead, will be, not a possibility of the future, but a probability. That the leaders of this movement in favor of equal rights look for such a result, I have not the slightest doubt; for, not many days ago, Susan B. Anthony stood beside

the chair of a circuit judge in one of our court-houses, and, before taking her seat, remarked that there were those in her audience who doubtless thought "that she was guilty of presumption and usurpation," but that there would come a day when they would no longer think so. Statistics show clearly and conclusively that there is an alarming increase of suicide and insanity among women, and I attribute this wholly to the already changed environment of our women. As the matter stands, they have already too much liberty. The restraining influences, which formerly made woman peculiarly a housewife, have been, in a measure, removed, and woman mixes freely with the world. Any new duty added to woman as a member of society would modify her environment to some extent and call for increased activity. When a duty like suffrage is added, the change in her environment must, necessarily, be marked and radical, with great demands for increased activity. The right of suffrage would, unquestionably, very materially change the environment of woman at the present time, and would entail new and additional desires and emotions which would be other and most exhausting draughts on her nervous organism.

The effects of degeneration are slow in making their appearance, yet they are exceedingly certain. The longer woman lived amid surroundings calling for increased nervous expenditure, the greater would be the effects of the accruing degeneration on her posterity. "Periods of moral decadence in the life of a people are always contemporaneous with times of effeminancy, sensuality and luxury. These conditions can only be conceived as occuring with increased demands on the nervous system, which must meet these requirements. As a result of increase of nervousness, there is increase of sensuality, and, since this leads to excess among the masses, it undermines the foundations of society—the morality and purity of family life" (Krafft-Ebing). The inherited psychical habitudes handed down through hundreds and thousands of years would prevent the immediate destruction of that ethical purity for which woman is noted, and in the posession of which she stands so far above man. I do not think that this ethical

purity would be lost in a day or a year, or a hundred years for that matter; yet, there would come a time when the morality of to-day would be utterly lost, and society would sink into some such state of existence as we now find *en evidence* among the Nairs. In support of this proposition I have only to instance the doctrines promulgated by some of the most advanced advocates of equal rights. The "free love" of some advanced women, I take it, is but the free choice doctrine in vogue among the Nairs and kindred races of people.

John Noyes, of the Oneida Community, where equal rights were observed, preached the same doctrines. It is true that these people are degenerate individuals, psychical atavists; yet, they faithfully foreshadow in their own persons that which would be common to all men and women at some time in the future, if equal rights were allowed and carried out in their entirety.

This is an era of luxury, and it is an universally acknowledged fact that luxury is one of the prime factors in the production of degeneration. We see forms and phases of degeneration thickly scattered throughout all circles of society, in the plays which we see performed in our theatres, and in the books and papers published daily throughout the land. The greater portion of the *clientele* of the alienist is made up of women who are suffering with neurotic troubles, generally, of a psychopathic nature. The number of viragints, gynandrists, androgynes, and other female psycho-sexual aberrants is very large indeed.

It is folly to deny the fact that the right of female suffrage will make no change in the environment of woman. The New Woman glories in the fact that the era which she hopes to inaugurate will introduce her into a new world. Not satisfied with the liberty she now enjoys, and which is proving to be exceedingly harmful to her in more ways than one, she longs for more freedom, a broader field of action. If nature provided men and women with inexhaustible supplies of nervous energy, they might set aside physical laws and burn the candle at both ends without any fear of its being burned up. Nature furnishes each individual with just so much nervous force and no

more; moreover, she holds every one strictly accountable for every portion of nervous energy which he or she may squander, therefore, it behooves us to build our causeway with exceeding care, otherwise we will leave a chasm which will engulph posterity.

The baneful effects resulting from female suffrage will not be seen to-morrow, or next week, or week after next, or next month, or next year, or a hundred years hence, perhaps. It is not a question of our day and generation; it is a matter of involving posterity. The simple right to vote carries with it no immediate danger, the danger comes afterward; probably many years after the establishment of female suffrage, when woman, owing to her increased degeneration, gives free rein to her atavistic tendencies, and hurries ever backward toward the savage state of her barbarian ancestors. I see, in the establishment of equal rights, the first step toward that abyss of immoral horrors so repugnant to our cultivated ethical tastes—the matriarchate. Sunk as low as this, civilized man will sink still lower—to the communal *Kachims* of the Aleutian Islanders.

EDITOR'S TABLE.

—For reasons not fully set forth, a considerable number of persons at one time adopted the opinion that the coëducation of the sexes possesses advantages over their separate education, and accordingly that system has been introduced into numerous schools of various grades. Consideration of certain facts of nature would, it might be supposed, have suggested that there might be some objections, but it is not the habit of a large class of persons to consider natural facts in the matter of sex. Now that the system has been in operation for many years, it is possible to see more clearly than before, whether the suspicions of the opponents of the system were well-founded or not. We make no account of the opposition of persons who think a college or university education unnecessary for women. Among the best educated men, such a position probably has few supporters.

Experience shows that in classes composed of both sexes, order is more easily maintained; boys are less disorderly and girls are less silly. The natural instinct for the respect of the other sex works wonders in this, as in other relations of life. Hence many teachers and professors think highly of coëducation. If we consider the interests of the students rather than those of the teachers, however, a different conclusion is indicated. It is well-known that the rate of growth in its later years is widely different in the sexes; the female becoming mature several years earlier than the male. This fact is the simple explanation of the natural antagonism which exists between the sexes of identical age during their "teens." Neither finds its ideal in the other sex of its age, the young woman especially and naturally finding it in older men who are as mature as herself. In mixed classes she will often excel the boys and take the prizes, a consequence not only of her maturity, but also of her greater sensitiveness to the penalties of failure. That women have, of later years, so often taken leading positions in competitive examinations is not necessarily an evidence of a corresponding superiority of intellectual endowment, but is often the natural result of the inequality of development between herself and her male competitors. We would, in fact, look for such a result as a necessary consequence of the conditions.

The effect of this state of affairs is bad on both sexes. It leads to mistaken conclusions as to the relative capacities of the two, which may lead to disastrous results in after life. It is calculated to produce in a considerable class of boys a distaste for study, and a preference in after years for uneducated women. To this extent it retards rather than aids human progress. It is a fact that, in a number of coëducational schools, the girls largely outnumber the boys, since the latter fail to become interested in their studies, and prefer to leave school and go into business. Whether it induces in girls a contempt for the intellectual furniture of the opposite sex we are not in a position to say, but it has done a great deal towards confirming certain doctrinaires in their a priori belief in the intellectual equality of the sexes.

It is alleged that there are moral reasons why coëducation is better than separate education, and this opinion is well-founded so far as it relates to the mutual benefits of association. But this association need not necessarily be in classes. A model institution would be one in which the classes should be separate, but association at other times easy. Such association could be obtained at meals and on other stated occasions, so as to represent as nearly as possible the family relation.

In universities, the graduate courses should be open equally to both sexes, since those who seek them are mature and stand on an equal footing.

—Experience of the effects of electrical currents on the human body does not sustain the New York method of executing criminals by electric shocks as either effective of humane. We have, so far, failed to find an electrician who can describe the course of an electric current after it enters the human body. Experience has abundantly shown that some men may tolerate currents of much higher voltage than others, so that there is no fixed standard of fatal efficiency. It is not certain that persons apparently killed by such currents are really dead, for there are cases of resuscitation from shocks of a strength which the New York executioners suppose to be fatal. The offer of experts to rescusitate the victims of the electric chair have been declined by the New York authorities. The testimony of some persons who have been resuscitated from apparent death by electricity, is that while all their motor functions were suspended, their consciousness was active. There may then be some truth in the assertion that the real execution under the New York law takes place at the autopsy. We cannot but regard the enterprise of the authors of this law as premature, and as involving a trifling with unknown conditions, which is barbarous. The law should be repealed. As a substitute for this and all other forms of execution, the guillotine has everything in its favor.

Our hopes of the benefits to science to be derived from the Field Museum of Chicago have not been realized. Nearly all of the scientific men who originally obtained positions there, have left it with expressions of dissatisfaction. This was to have been expected as a consequence of the organization which Mr. Field permitted. The most active member of the management was a successful lumber merchant, and the appointee as director was of an equally impossible stamp. Americans sometimes wonder why European Museums of Natural History are so much superior to our own. The answer is that in Europe competent scientific men manage them; in America they do not, with the sole exception of a museum which is connected with a university (Harvard), and one in New York where exceptional sagacity holds the reins. Chicago begins, in this matter, at the bottom of the ladder, and we will live in hopes. Perhaps Mr. Field himself will some day come to the rescue, and insist that the director of the Museum shall be a scientific man of proved ability, and that the only function of the

trustees shall be to see that the investments are good, and that the expenses shall not exceed the income.

THE LAST volume of the reports of the Challenger Expedition has been published, and English biologists are reviewing the work. A late number of our esteemed contemporary "Natural Science," consists mainly of a symposium on the results obtained, and the editors congratulate their countrymen on the successful conduct and completion of the enterprise. We join in their congratulations; for Englishmen may well be proud of their work; and Carpenter as its projector, and Moseley and Murray as its managers, will ever be held in esteem by naturalists the world over. By the way our contemporary in another number shows that there is eruptive matter in some of its editorial substrata. It comes to the surface in some strong language anent of a short communication by Dr. Patton to the NATURALIST. Perhaps the irate editor is not familiar with all the circumstances of the case. Neither are we.

RECENT LITERATURE.

From the Greeks to Darwin.[1]—In a volume of 260 pages Professor Osborn presents the salient points in the history of the growth of the evolution idea in the European mind. Beginning with the Greek philosophers, the author discusses their conceptions and gives a résumé of the legacy of the Greeks to later evolution. Then follows an account of the contributions of the theologians of the Middle Ages, and of the natural philosophers from Bacon to Schelling. Due credit is given both to the speculative evolutionists, of whom Oken is a type, and to the great naturalists of the eighteenth century who laid the real foundations of the modern evolution idea. Several pages are

[1] From the Greeks to Darwin. An Outline of the Development of the Evolution Idea. By Henry Fairfield Osborn. New York, 1894. Macmillan and Co.

devoted to tracing the rise and decline of evolutionary thought in France, from Buffon to Geoffroy St. Hilaire (Isidore), in which attention is called to the opposing views of what may be termed the Buffon-Lamarck adherents and those of the Cuvier-Linnaeus school. The closing chapter is an exposition of the views of Darwin and Wallace and their precursors in the teaching of natural selection.

This review of the history of thought on organic evolution is timely and will interest a large circle of readers. It is judicial in treatment, and although the author is known to have decided opinions on the subject, they do not appear. He reminds us that the early fathers of the Christian church, and conspicuously Augustine, were evolutionists and that Suarez was not, although the contrary has been alleged. He points out the services of Buffon and Erasmus Darwin to thought, and shows the imaginative genius of the former, and the practical sagacity of the latter. In discussing Lamarck, while crediting him with clear-minded sagacity, he shows the superficial character of many of his attempted explanations. Nevertheless he says in closing his review, "We must close by placing Lamarck in the first rank. He was the first naturalist to become profoundly convinced of the great law, and to place it in the form of a system." He shows that Lamarck was the first author to understand the nature of actual phylogeny, and depict it graphically in true form. Of Darwin, the author says, "The long retention of his theory from publication marks the contrast of his caution with the impetuousness of Lamarck." But it must be remembered that the Recherches sur l'Organisation des Corps Vivants was not written until 1802, when Lamarck was no longer young, and had spent his life in study. Further, "He" (Darwin) "sought a hundred facts and observations where his predecessors had sought one; his notes filled volumes, and he stands out as the first evolutionist who worked upon true Baconian principles. It was this characteristic which, combined with his originality, won the battle for the evolution idea." This is an estimate of Darwin which time will confirm.

The perusal of this book will give a just view of the history of thought on the doctrine of organic evolution, and will enable the reader to determine the respective parts which the contributors to our knowledge have played. The improved means of reaching conclusions which the additions to the store of facts in later periods placed within the reach of later authors, are referred to. The vast increase in our knowledge of facts since Darwin, have thrown so much light on the subject that it is to be hoped that Professor Osborn will at some future

time favor us with a volume on the advances made during this period also.

"**The Glacial Nightmare and the Flood.**"[1]—To American geologists, the title of this work is almost a challenge, and might cause it to be ignored, but to every student of superficial geology it is an invaluable book. It is a well-arranged history of the observations and growth of the science of superficial geology. To many of the fathers of this department of science, it is a tardy justice, and impresses a fair reader with the vast array of facts which were collected at an early date, not in Europe alone, but also in America, leaving for the later observers far less new work than our modern writers usually recognize. Another lesson taught demonstrates that the generalized conclusions of the greatest idols of science are by no means established, and often retard progress. The teachings of each succeeding generation replace, to some extent, those of the preceding, until at last reaction sets in and separates the chaff and shows us how much the early scientific geniuses did for their science, though, perhaps, drawn off into erroneous by-ways.

The work fairly sets forth the rise of the doctrine of floods and its abandonment; of the growth and limitation of the iceberg theory; of the origin and culmination of the glacial theory, with Schimper at the head, and originating the term *Ice Age*. Thus far the author's hand is hardly seen in the book. The treatise is of special value in systematically bringing together the facts and views and doing justice to the authors of works, many of which have been overlooked or are not accessible to American geologists.

On the subject of the unity of the glacial period the evidence is fairly stated, but the author marshalls an array of data favoring the unity of the Age in its general aspect, a point upon which American glacialists differ. The difficulties in accepting the astronomical causes of the Ice Age are fairly set forth, and these adverse conclusions will be received by most American geologists. The cause of glacier motions, and the mechanical effects of glaciers are discussed from their physical aspects, and appear very satisfactory to most observers. The facts showing the former extension of glaciers are arranged, and show how the ice-cap theory has given place to continental glaciers. But here the work is directed against the extreme views, giving rise to the title of the book, on the ground of lack of evidence, and challenges the right of

[1] By Sir Henry H. Howarth, K. C. I. E., M. P., F. G. S., etc. 2 vol. pp. 1–920. Sampson, Low, Marston & Company, London.

appealing to transcendental views. Although some American glacialists will here dissent, yet the treatment of the evidence is very fair, and from the facts collected the book cannot be overlooked by any scientific observer.

The work closes with suggestions to explain some difficulties carefully analyzed, wherein the author appeals to "waves of translation," a modification of the old doctrine of catastrophies (as does also Prof. Prestwich in some of his recent contributions). It is surprising that the idea of cataclysms in some form, whether glacial or otherwise, has permeated the views of so many writers, often without their apparent knowledge, who are considered good disciples of uniformitarianism.

In spite of the title, the work is just such a volume of condensation of observations, gathered from the whole world, as is needed for a manual of references, for these are much more prominent than the views of the author, even in the latter part of the book. It, however, shows that there may be two views of great problems. From the work, one is almost surprised to find how much the early geologists in America had done in surface geology, which has been almost forgotten, yet this formed the foundation of even the modern science of superficial geology.

—J. W. S.

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General Notes.

MINERALOGY.[1]

Universal Stage for the Microscope.—Federow has done a great service to mineralogists and petrographers by introducing instruments based on the universal or theodolite principles. His application of these principles to the measurement of crystal angles is the goniometer with two graduated circles, which has already been referred to in these notes. Extending his study to the field of crystallographic-optical measurements, he has devised the universal microscope stage,[2] which increases the usefulness of the microscope by permitting a quite new class of observations to be made. The microscope stage now in use permits of only such motions as always retain the slide in a plane parallel to the initial one. Federow's universal stage allows the slide to be moved into any position whatsoever by two rotations about axes normal alike to one another and to the microscopés axis. He has described and figured two different types of stage, one better adapted to ordinary work and also permitting the slide to be immersed in liquids if desired, while the other has the advantage of greater simplicity and has a convenient arrangement for orienting the slide in its own plane, so that any line (e. g., a twinning trace) may be brought parallel to the immovable axis of the stage. In answer to some inquiries,

[1] Edited by Dr. Wm. H. Hobbs, University of Wisconsin, Madison, Wis.

[2] Zeitsch. f. Kryst., xxii, pp. 229–268, pl. 9 (1893).

Professor v. Federow has kindly informed the editor of these notes that he has designed a third and simpler type of stage, specially adapted to petrographical work, which will shortly be described. All these forms can be attached to any of the standard types of petrographical microscopes by screwing to the mechanical stage. They require, however, a special form of slide, which is circular, with a diameter of about 2 *cm.*, and, when in use, this is held in an ebonite holder with circular opening, in which the slide can naturally be given any desired orientation.

Parallel polarized light is used with this stage, and the presence of an axis of the ellipsoid of elasticity in any section is indicated by first bringing the two principal directions of the section parallel to the two axes of the stage and then rotating the slide about each separately. If either of the principal directions is an axis of elasticity, the slide will evidently remain dark when rotated about the axis normal to it, whereas otherwise it will show interference colors. This affords the following scheme for determining the symmetry of a mineral from examination of random sections in a rock slide:

Isometric. Every section is isotropic.

Hexagonal and Tetragonal. Every section has one axis of elasticity.

Orthorhombic. Sections lying in the zones of the three crystallographic axes contain an axis of elasticity.

Monoclinic. Sections belonging to the zone of the axis of symmetry contain an axis of elasticity.

Triclinic. Entire lack of such sections.

Some of Federow's applications of this instrument to the study of the feldspars will be referred to later.

A somewhat different form of stage embodying the same idea, but adapted to the study of the ordinary form of slides, has been since devised by Klein and manufactured by Fuess for attachment to his instruments.[3] Klein[4] has also designed a form of this stage (likewise manufactured by Fuess for his large stand) to be used with convergent as well as parallel polarized light, and this can be used to find the position of the optic axes and measure the optical angle in crystals as well as in sections.

Connection Between Atomic Weight of Contained Metals and Morphological and Optical Properties of Crystals.—The relations found by Tutton to exist between the atomic weights

[3] Groth, Physikal. Kryst., 3d ed., p. 749, figs. 688 and 689 (1895).

[4] Ibiden, p. 750, fig. 691. Cf. also Sitzungsber. d. Akad. d. Wiss., Berlin, 1895, p. 91.

of the contained metals and the crystal characters of the potassium, rubidium, and cæsium double sulphates of formula $R_2M(SO_4)_26H_2O$,[5] have been found by Muthmann[6] to hold also for the permanganates. Continuing his studies Tutton[7] has made an equally exhaustive crystallographic study of the normal sulphates of the same alkali metals. The earlier determinations made on these substances seemed to be in conflict with the facts brought out by Tutton in studying the double sulphates, but after most exhaustive and precise observations with specially-devised apparatus, Tutton is able to show that the recorded observations on these salts are incorrect, and that the intermediate position crystallographically of rubidium is established for this series as well as the other. There is shown to be a progression corresponding to the increase of atomic weight of the contained metal as regards the axial ratio, the size of the interfacial angles, and the molecular volume. The differences in the magnitude of the analogous angles, seems, however, to be less, the higher the symmetry, approaching, Tutton suggests the absolute identity requisite to isometric symmetry. The habit of the crystals seems to obey the same law. In a discussion of the relative linear dimensions of the crystal elements of the Bravais-Sohnche space lattice, is communicated a simple method of determining these values which was suggested by Becke. Becke's formulæ are:

$$a_0 = \sqrt[3]{\frac{a^2V}{c}} \qquad b_0 = \sqrt[3]{\frac{V}{ac}} \qquad c_0 = \sqrt[3]{\frac{c^2V}{a}}$$

in which a_0, b_0, and c_0 (X Y Z of Muthmann) are the *relative* dimensions of the crystal element in the direction of the correspondingly named crystal axes; a, b, and c are the unity lengths of the crystal axes; and V is the molecular volume. Tutton proposes to call the distances a_0 b_0 c_0 (Muthmann's *topische axen*) *distance ratios of the crystal elements*, and, as they are only relative values, to make one equal to unity as in the case of axial ratios. When these values are determined for the three sulphates, it is found that rubidium occupies the intermediate position. Tutton also finds that these salts follow the Bravais-Sohnche theory in that the planes of cleavage ⟨ (010) most perfect and (001) less perfect ⟩ are the planes in which the elementary parallelograms of the lattice system are respectively smallest and next smallest.

The optical study consisted in the determination of the principal indices of refraction in prisms prepared with unusual care by the deli-

[5] See these notes.

[6] Zeitsch. f. Kryst., xxii, p. 497.

[7] Jour. Chem. Soc. London, 1894, pp. 628–717.

cate apparatus described by him before the Royal Society, and also in the measurement of the optical angle (in sections prepared accurately normal to a besectrix by means of the same apparatus) in five different wave lengths of light. Here again the intermediate position of rubidium is proven by the values of the indices of refraction along corresponding crystallographic axes. Rubidium sulphate is found to be quite a unique substance optically, having an *extremely* low double refraction (*small differences* between the indices of refraction), but, in general, a large optical angle (*large relative differences* between refractive indices), with high dispersion of the optic axes due to the fact that differences in the magnitude of $2V$ for different wave lengths are large by reason of the extremely small differences between the indices (low double refraction). Similarly the changes in $2V$ caused by rise of temperature are abnormally large. Further, since the index of refraction along crystallographic c increases with rise of temperature faster than those along the other axes, and more in amount than the difference between the indices along c and b at the ordinary temperature, the result is a closing up of the optical angle with a rise of temperature and an opening out in the plane normal to its first position.

The following figures, which are the ratios of the optical elasticities along the crystallographical axes, tell this story:

At ordinary temperature $a : b : c = \overset{c}{0.9991} : \overset{a}{1} : \overset{b}{0.9999}$

At 180°, $a : b : c = \overset{c}{0.9993} : \overset{b}{1} : \overset{a}{1.0006}$

Somewhat similar changes have been found to occur in heating potassium sulphate, but only at higher temperatures. The many results of this elegant and thorough study can not be given in a review of these proportions, and the reader is referred to the original paper.

Boleite and Nautokite from Broken Hill, N. S. W.—Liversidge[8] describes boleite from Broken Hill, N. S. W., in cubic crystals as much as seven millimetres on an edge and modified by both the octahedron and the dodecahedron. The matrix is hematite and quartz. The mineral has heretofore been found only at Boleo in Lower California. From the same locality the same writer describes nautokite, the lower chloride of copper, in fragments of crystals, and beautiful crystals of cerargyrite and cuprite.

New Minerals from Chili.—The late Dr. Dietze,[9] of Tantal, Chili, a few years since studied chemically several new minerals from

[8] Read before the Royal Society of New South Wales, June 6th, 1894. (Separate.)

[9] Zeitsch. f. Kryst., 19, p. 445 (1891).

the salt pampas of that country. Osann[10] has recently studied three of these minerals crystallographically and optically. Some of his results are summarized below:

Darapskite ($Na_2SO_4+H_2O$, Dietze) from Pampa del Toro near Pampa, where it occurs abundantly with blödite. Monoclinic with axial ratio $a:b:c = 1.5258:1:0.7514$. $\beta = 77°5'$. Habit tabular parallel to the orthopinacoid. The observed forms were (100), (001), (010), (110), ($\bar{1}01$), ($\bar{2}01$), (101), (302), (011), ($\bar{1}11$), (111), and (121). Twins are common according to (100), and are sometimes polysynthetic. H, 2–3, G, 2.203. Easily soluble in water.

Lautarite $\{Ca(IO_3)_2$, Dietze$\}$ from Calcium Chloride Pampas, also Pampa del Pique III and in Pampa Grove. Monoclinic with axial ratio $a:b:c = 0.6331:1:0.6462$. $\beta = 73°38'$. The prismatic crystals show the following forms: (110), (120), (010), (001), (011), (101) and ($\bar{1}01$). Cleavage parallel to (011). The crystals vary from colorless to bright wine-yellow, and are difficultly soluble in water. H, 3–4, G, 4.59 (Dietze).

Dietzite. This mineral occurs in the Chloride of Calcium Pampas, and was determined by Dietze to have the formula 7 Ca $(IO_3)_2$ 8 Ca Cr O_4. It has monoclinic symmetry with axial ratio $a:b:c = 1.3826:1:0.9515$. $\beta = 73°28'$. Crystals tabular according to 100, possessing the forms: (100), (010), (001), (110), (210), ($\bar{1}01$), ($\bar{2}21$) and ($\bar{2}23$). H, 3–4, G, 3.698. Soluble in hot, but only slightly soluble in cold, water. The mineral is named by Osann in honor of the finder, Dr. Dietze, who perished in a snow storm while on a scientific expedition in the Andes. Lautarite and Dietzite are interesting as being the first salts of iodic acid that have been found in the mineral world.

Miscellaneous.—Rinne[11] determines the symmetry of crystals of metallic aluminium to be probably isometric from a study of quite perfect growth forms. Lacroix[12] describes well crystallized epidote from or near Voheimar, Madagascar, which have developed the base, orthopinacoid, the unit positive orthodome, and also (210), ($\bar{1}02$), (011) and ($\bar{1}11$). He also makes a correction to his earlier paper[13] on the pyromorphite of New Calidonia, adding the form (11$\bar{2}$1) and replacing the described forms (50$\bar{5}$4) and (10.0.$\bar{1}$0.1) by the forms (15.0.$\bar{1}\bar{5}$.14) and (90$\bar{9}$1). Ussing,[14] in connection with a mineralogical-petrographical

[10] Ibidem, 23, pp. 584–589, pl. 7 (1894).

[11] Neues Jahrbuch f. Min., etc., 1894, II, pp. 1–2.

[12] Bull. Soc. Franç Min., xvii, pp. 119–120, May, 1894.

[13] Ibidem, pp. 120–121.

[14] Mineralogisk-petrografiske Undersogelser af Gronlandske Nefelinsyeniter og beslaegtede Bjaergarter, by N. V. Ussing, pp. 224, pls. 7, 1894.

investigation of the Greenland nephelene syenites and their associated rocks, describes nepheline altered to cancrinite, sodalite, analcite, hydronephelene, natrolite, and potash mica; also sodalite altered to analcite and natrolite and eudialite altered to katapleite and zircon. Besides numerous varieties of feldspar, augite and hornblende, he describes Ainigmatite and Kölbingite from these rocks. The work is printed in the Danish language.

WM. H. HOBBS.

GEOLOGY AND PALEONTOLOGY.

The Protolenus Fauna.—An important paper based on the collections made by W. D. Matthews, of fossils from the lower part of the Cambrian rocks of New Brunswick in 1892, '93 and '94, was recently communicated to the New York Academy of Sciences by G. F. Matthews. From this article the following abstract has been made of the character of the fauna and the conclusions arrived at from its study.

The fauna described is one of the oldest known. It consists of Foraminifera, Sponges, Molluscs and Crustaceans. All the Foraminifera described are referred to the genera Orbulina and Globigerina; the Sponges include Protospongia and others. The Molluscs are mostly hyalithoid shells of the genera Orthotheca, Hyolithus and Diplotheca. The Crustaceans are chiefly of the two groups, Ostracoda and Trilobita, of which the former are remarkable for the large number of genera and species, as compared with the trilobites; two predominant and characteristic genera are Hipponicharion and Beyrichona. All the trilobites are of genera peculiar to this fauna, except Ellipsocephalus, which, although one of the dominating types, also occurs in the Paradoxides beds of Europe. The most characteristic genus of trilobites is Protolenus, which is abundantly present in the typical beds.

The following are some of the salient characters of the fauna as at present known: *All the trilobites have continuous eye-lobes.* This is decidedly a primitive character, and its value in this respect is shown by the genus Paradoxides of the overlying fauna, which began with small species having such eye-lobes, and culminated in the large forms of the upper Paradoxides beds in which the eye-lobe was considerably shortened.

The important family of Ptychopariidae is absent.

The genus Conocoryphe is absent. This is specially a type of the Lower Paradoxides beds, and under the name of *Conocoryphe trilineata* (*Atops trilineatus*) is claimed as a characteristic fossil of the Olenellus Zone.

The genus Microdiscus is absent. This trilobite is especially characteristic of the Olenellus Zone, and continued to live with Paradoxides.

The genus Olenellus is absent. Hence, although this fauna apparently holds the place where we might naturally expect to find Olenellus, that genus proves to be absent, or, at least, not at all characteristic; and, as so many of its associate genera also are absent, *we cannot regard this fauna as the fauna of Olenellus.*

In this fauna there is a very primitive assemblage of Brachiopods and at least one pelagic mollusc, having a helicoid shell and supposed to be free swimming Heteropod.

The author distinguishes this fauna from that of Olenellus by two marked features; it is more *primitive* and also more *pelagic.* The former is shown by the trilobite forms, and the latter by the following facts: The absence of forms differentiated for shore-conditions; trilobites with fixed outer cheeks are absent; calcareous corals and sponges are rare; thick shelled Brachiopods and Orthidae are rare: no Lamellibranch is known, but Foraminifera are common in some of the beds. (Science, April, 1895.)

Formation of Oolite.—In view of Dr. Rothpletz's recent investigations concerning the lime-secreting fission-algae of the Great Salt Lake, and his own studies of the structure of the Jurassic Pisolite, Mr. Wethered offers the following explanation of the formation of Oolitic granules:

Minute fragments of remains of calcareous organisms, such as corals, polyzoa, foraminifera, crinoids, etc., collected on the floor of the sea. These became nuclei to which the oolite-forming organisms attached themselves, gradually building up a crust. Sometimes this growth was concentric, sometimes at right-angles to the nucleus, or the two combined. When the growth was concentric, other tubules frequently cropped up in other directions and crossed the concentric tubules. At the same time, calcareous material was secreted, and the interstitial spaces between the tubules were filled.

The oolite-forming organisms may be allied to the algae, or they may be even lower in the scale of life. *Girvanella*, identified by the author in the Jurassic Pisolite, the first type of oolite-forming organism discovered, is simply a tubule. (Quart. Journ. Geol. Soc., 1895.)

The Extinction of Saurians.—In regard to the extinction of species, Mr. Charles Morris offers as an explanation of the disappearance of the Cretaceous reptiles, an indirect assault by the placental mammals, viz.: the destruction of the eggs, and possibly of the young, of the reptiles. The author points out that the mammals, equipped with a higher grade of intelligence than their powerful rivals, probably adopted new methods of attack more rapidly than the reptiles acquired means of defense, so that the latter eventually found themselves at a disadvantage in the competition for supremacy. Multitudes of prowling creatures, small and agile, having become aware of usefulness of reptiles' eggs for food, would soon bring about a perceptible diminution of reptilian life. Only the smaller and most prolific forms would continue to exist, or those that developed means of hiding or otherwise protecting their eggs from the assaults of the hungry mammals. (Proceeds. Phila. Acad., 1895.)

The Geology of Cuba.—The following geological history of Cuba is given by Mr. Robert T. Hill. The conclusions are based on stratigraphic and paleontologic data obtained during a personal recognoissance made in 1894.

1. In Pre-Tertiary times, an old land existed, almost as extensive in area as the present Island. Whether this old land was insular, multi-insular, or connected with other Antillean areas on the mainland, I will not speculate. The submarine topography indicates that it was not. Its composition and structure, however, show that it was an area of active vulcanism accompanied by great metamorphism and eruptive flows. If there are preserved in it any traces of Pre-Tertiary sedimentation, they are largely overwhelmed and almost obliterated by the vulcanism, metamorphism and later erosion. Paleozoic, Triassic Jurassic and Cretaceous sediments have been reported by De Castro in localities, but their physical history is unknown.

2. It is also certain that during Tertiary times, embracing the Eocene and Neocene periods, this ancient nuclear land, with all of its geographic outlines, completely subsided beneath sea-level, and that it was covered with limestone sediments, which were originally derived from the sea, not the island itself, for there is no semblance of limestone material in the rocks of the Pre-Tertiary land which could have furnished material for the Tertiary rocks. That this subsidence was profound we may reasonably conclude from the thickness of the older nucleal region, now visibly covered by the limestone beds, which have been horizontally elevated to a height of at least two thousand feet. In other words, the

Pre-Tertiary subsidence may have been at least to an equal depth. During this epoch of Tertiary subsidence, a thousand feet of Tertiary limestone were accumulated over the old nucleal island.

3. After the close of Tertiary times, the Tertiary sediments were greatly warped and folded, concurrently with an emergence of the land from the sea. This movement was orogenic.

4. Following this began the epoch of epeirogenic or regional elevation. During Pleistocene time the island underwent the first of these upward impulses to its present height, with the exception of about six hundred feet represented in still later movement. This older Pleistocene or Yunque elevation raised the main area to a height of at least two thousand feet in its eastern half, and fifteen hundred feet in its western half. How much higher it extended we cannot tell, so great has been the erosion. This elevation was so rapid and general throughout the island that no coastal accumulations are preserved around its perimeter. This elevation likewise developed the present outline of the island almost in its entirety, and perhaps in greater area, which has since been destroyed by erosion.

5. Following this older and greater Post-Tertiary elevation, and intervening between it and the time of the Cuchilla, or five hundred foot level, there was a long period of erosion, cutting down the country to the Cuchilla plain, which was at that time marine base level.

6. Renewed and general elevation of the island commenced in recent times, after the period of rest recorded in the Cuchilla level. The later terraces, sea cliffs, base levels and modern coral reefs and savanna deposits of the south coast were then elevated. It is also evident that in this later period, elevation was intermittent, accompanied by slight pauses. It is difficult to exactly fix the time of this latest elevation. It was certainly very recent, and a considerable period later than the old Yunque elevation. It cannot be older than the late Pliocene, and it may or may not be in progress at present. (Bull. Harvard Mus. Comp. Zool., Vol., XVI, 1895.)

Former Altitude of Greenland.—Recent glacial studies in Greenland was chosen for the subject of the annual address of the Geological Society of America, delivered by the President, T. C. Chamberlin. In his closing remarks, the speaker referred to the former altitude of Greenland as follows:

"There is no ground to question the former elevation of Greenland. Its plateaus, like its valleys, indicate this; but glacialists are especially concerned to know whether the former elevation of Greenland was

coincident with its glaciation or not. Aside from the contours of the plateaus and valleys, which seem to indicate a fashioning rather by meteoric agencies than by pronounced glaciation, the driftless area appears to afford the most specific ground for induction. Bearing in mind that this is a small area between the present edge of the ice and sea-level, which would be overridden easily and completely by an advance of the ice-edge of less than five miles, it seems necessary to conclude that at the time of the former greater elevation the climatic agencies of glaciation could not have been what they are now, but for the increased elevation would have caused an extension sufficient to overwhelm the driftless area. If it is safe to conclude that elevation favors glaciation, then it is necessary to conclude that during any period of previous glaciation, there was here no elevation sufficient to cause an advance, unless accompanied by counteracting adverse climatic conditions. The ruggedness of Dalrymple Island bears similar testimony. The general angularity of the coastal mountains of south Greenland throw the weight of their evidence in the same direction. It would appear, therefore, that the former elevation of Greenland was not coincident with conditions favoring glaciation." (Bull. Geol. Soc. Am., Vol. 6, 1895.)

Age of the Sandstones of Crowley's Ridge.—Crowley's Ridge stretches across north-eastern Arkansas from the Missouri line to the Mississippi River at Helena. At numerous localities in this ridge a heavy deposit of cherty gravel is exposed in which are small (and rarely very large) masses of a compact, fine-grained quartzite. The gravel is undoubtedly Plistocene, and, until recently, the sandstones were supposed to be of Paleozoic age. Dr. D. D. Owen referred them to the Potsdam from their lithological character. An investigation by Mr. R. Ellsworth Call, however, results in the discovery that they are indurated sandstones of the same age, and sharing in the common history of the gravels through which they protrude. Dr. Branner has observed similar facts of metamorphosis in Brazil, and these corroborate the view suggested by Mr. Call that the metamorphism is due to weathering.

The facts ascertained by Mr. Call concerning this disputed formation are summed up as follows:

"These rocks are of limited occurrence, covering a few hundred acres all told; they are found at rather low elevation in the hills, although they sometimes occur as far as the very tops of the highest points in the ridge country; they have yielded fossils of Lower or Eocene Ter-

tiary age; they have probably resulted from weathering processes; are metamorphic in character, and have no history of dynamic origin or of present or past dynamic change. Their former reference to the palaezoic is no longer tenable, and they stand as a unique instance of the induration of soft sandstones in the southwest." (Proceeds. Ind. Acad. Sci., Vol. III, 1893–1894.)

Geological News.—The remains of two reptiles are reported from the Triassic of Shasta Co., California, by J. C. Merriam. The larger individual is represented by eight consecutive vertebræ, a few fragments of ribs and both coracoids. These present an assemblage of characters that necessitate the creation of a new genus, *Shastasaurus* with the specific name *pacificus*. The second and smaller individual represents a very different form from that described above, but the material is insufficient for specific characterization. (Am. Journ. Sci., 1895.) The figures and description of Mr. Merriam indicate that the alleged relationship to Ichthyosaurus is very doubtful.

A fossil Liverwort is described by Mr. F. H. Knowlton from the Lower Yellowstone of Montana. The species, which represent the only extinct form from North America, is allied to the genus Preissia, and a new genus, Preissites, has been made for its reception. The fossil was found by Professor Lester Ward, to whom the species is dedicated. (Bull. Torrey Botanical Club, Oct., 1894.)

Mr. R. T. Hill records the occurrence of Radiolarian earth at Baracoa in the island of Cuba. The strata are vertical and over 500 feet in thickness. The rock is chalky in appearance, with occasional thin separation-layers of gray-blue clay, and some flint-like siliceous nodules: sponge-like spicules and echinoid fragments are found in it, but no diatoms. It appears to lie below certain yellow beds identified as Miocene, (Bull. Mus. Comp. Zool., Harvard, 1895.)

Records of well-borings in Iowa show the presence of numerous buried drainage channels. A comparison of the data indicates that in pre-glacial time the land surface of the State stood at an elevation considerably above that now obtaining. Throughout the driftless area there is evidence that the region, after being reduced to a base level of erosion, has been elevated, and is now being reduced to a second base level. (Proceeds. Iowa Acad. Sci., Vol. II, 1895.)

Captain F. W. Hutton publishes a classification of the genera of the Dinornithidæ, based on the characters of the axial skeleton, and, in the absence of illustrations, gives keys to assist in distinguishing the genera. (Trans. New Zealand Inst., 1894.)

BOTANY.[1]

Summer-School Botany in the Mountains.—It may be of interest to teachers of botany in schools and colleges to know what has been found possible to accomplish in a short course in the Colorado Summer School of Science, Philosophy and Languages the present year. The school was held in the city of Colorado Springs at the foot of Pike's Peak, within easy reach of the vegetation of the plains, the cañons, foot-hills, and the strictly alpine regions. The numerous brooks and mountain streams supplied an abundance of aquatic forms, while the damp cañons furnished all kinds of fungous growths. Lichens, mosses and ferns were found in abundance, so that every section of the vegetable kingdom was well represented. Good rooms for lecture and laboratory work were set aside in the High-School building. The following outline was followed, with slight variation:

THE STRUCTURE OF PLANTS.

I. (*a*)—Cells. Protoplasm. Nucleus. The formation of new cells. Chlorophyll. Starch. Crystals.

II. (*b*)—Tissues. Rudimentary tissues. Permanent tissues.

III. (*c*)—The Plant Skeleton. Epidermis. The Fleshy Tissues.

IV. (*d*)—The Plant-Body. Homologies and Analogies. Transformation of parts.

THE PHYSIOLOGY OF PLANTS.

V. (*a*)—Water in the plant as a whole; in the protoplasm; in the cell walls. Source of water; movement of water; evaporation of water. Plant food; the compounds used; how obtained; how transported in the plant. Starch-making (carbon-assimilation); other assimilations.

VI. (*b*)—Growth. Effects of Heat and Light on Plants. The sensibilities of plants. The movements of plants.

CLASSIFICATION AND DISTRIBUTION OF PLANTS.

VII. General laws of classification. Relationship. Distribution of plants in space and time.

THE LOWER WATER-PLANTS.

VIII. (*a*)—The simplest plants (Class 1, *Schizophyceæ*), Water Slimes, Nostocs, and Bacteria.

IX. (*b*)—The Green Algæ (Class 2, *Chlorophyceæ*), Green Slimes, Pond-scums, Green-felts, Confervas, and their near relatives.

[1] Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.

X. (*c*)—The Brown Algæ (Class 3, *Phæophyceæ*), Simple Fruit-tangles (Class 4, *Coleochæteæ*), Red Seaweeds (Class 7, *Rhodophyceæ*) and Stoneworts (Class 8, *Charophyceæ*).

THE DEGENERATED PLANTS.

XI. (*a*)—The Sac-Fungi (Class 5, *Ascomycetes*) Mildews, Truffles, Cup-fungi, Black Fungi, Rusts and Smuts.

XII. (*b*)—The Higher Fungi (Class 6, *Basidiomycetes*), Puff-balls, Earth-stars, Bird's-nest Fungi, Mushrooms, Toadstools and Pore-fungi.

THE MOSSWORTS.

XIII. The Liverworts (Class 9, *Hepaticæ*) and the Mosses (Class 10, *Musci*). The undifferentiated plant-body; the Shoot with Stem and Leaves; Reproduction; Alternation of Generations.

THE FERNWORTS.

XIV. (*a*)—The Ferns (Class 11, *Filicinæ*). The prothallium; antherids and archegones; fertilization; growth of the embryo; the leafy plant; spore-cases and spores; germination of the spores. Alternation of generations. Classification of ferns.

XV. (*b*)—The Joint-rushes (Class 12, *Equisetinæ*). Comparison with ferns. The plant-body; spore-cases and spores. Extinct joint-rushes. The Lycopods (Class 13, *Lycopodiaceæ*). Comparisons with ferns and joint-rushes. The plant-body; spore-cases and spores. Extinct lycopods.

THE NAKED-SEEDED PLANTS (Class 14, *Gymnospermæ*).

XVI. Cycads, present and past; Conifers (pines, spruces, firs, etc.), structure of the flowers, fertilization, cones and seeds. Relationship of gymnosperms to lycopods.

THE COVERED-SEEDED PLANTS (Class 15, *Angiospermæ*).

XVII. (*a*)—The Flower (stamens, pistils, flower-leaves); fertilization; fruits; seeds.

XVIII. (*b*)—The lower group (Monocotyledons); water-plantains; lillies; aroids: palms; grasses; irises; orchids.

XVIII. (*c*)—The higher group (Dicotyledons).

XIX. (1)—Flowers with separate petals. Buttercups, mustards, pinks, mallows, geraniums, grapes, maples, roses, beans, myrtles, melons, cactuses and umbelworts.

XX. (2)—Flowers with united petals. Primroses, heaths, olives, gentians, phloxes, morning glories, figworts, mints, honeysuckles, bellworts and sunflowers.

The work was divided into an elementary and an advanced course, the former for those who took up the study of botany for the first time, and the latter for those who had already made some progress in the study. The attendance was large, considerably exceeding one hundred, and was composed almost entirely of teachers of maturer years, in all departments of school work, from the kindergarten to the high-school and academy.—CHARLES E. BESSEY.

VEGETABLE PHYSIOLOGY.[1]

Fischer on Bacteria.—Under the title Untersuchungen ueber Bakterien, Dr. Albert Fischer contributes an important paper to a recent number of Pringsheim's *Jahrbücher fur wissenschaftliche Botanik* (Bd. 27, H. 1, pp. 163, T. 5, Berlin, 1895). This paper consists of four parts: (1) New observations on the plasmolysis of bacteria; (2) The physiology of the flagella and of the movement; (3) The morphology of the flagella; (4) Classification. Of the five plates illustrating flagella, four are lithographic, and one is a collotype. The author appears to have made out pretty clearly for a good many forms that the contents of the bacterial cell is plasmolyzed even by a slight concentration of culture media such as takes place on the cover glass in drying or in the transfer of the organisms from a weaker to a more concentrated culture medium. This plasmolysis can be avoided by diluting the fluid very plentifully with water before making cover glass preparations from it. Only a very slight amount of sodium chloride is necessary to produce plasmolysis of a cover glass preparation, especially at the edge of the drop, viz.: 0.01 to 0.05 per cent. The occurrence of this phenomenon can be observed in a hanging drop as it dries. Plasmolysis disappears when watery stains are used, but is beautifully preserved by alcoholic stains, Ziehl's carbol fuchsin, or Delafield's haematoxylin. Many false conclusions have been drawn from such plasmolyzed bacteria. Here belong De Toni and Trevisan's genera *Pasteurella* and *Dicoccia*; the staining phenomena of the cholera vibrio, described by Rahmer; the bamboo-like joints sometimes seen in the anthrax bacillus; the polar bodies in the typhoid bacillus; the various granular structures in the tubercle bacillus, etc. The unstained, empty places

[1]This department is edited by Erwin F. Smith, Department of Agriculture, Washington, D. C.

in plasmolyzed bacteria have often been mistaken for spores. In weak salt solutions the phenomena of plasmolysis disappears in an hour or two; in strong solutions it disappears much sooner. This disappearance of plasmolysis and the reappearance of motility bear no relation to each other, but depend upon entirely different causes. To obtain good plasmolyzed cover-glass preparations that will fix and stain in that condition, the author recommends putting a trace of bacteria into a drop of a weak salt solution (0.25 to 0.50 per cent NaCl or 0.5 to 1.0 per cent KNO_3) and then carefully spreading out the drop so that it will dry in 3 to 10 minutes. The bacterial cell consists of a membrane, a protoplast in the form of a wall covering, and of cell sap, and has, consequently, the same structure as any other plant cell. Cell nuclei are still to be sought; a "centralkörper" is never present, when there seems to be one it is a misinterpretation due to the contracted protoplast, as in case of Bütschli's observations on *Spirillum undula.* In weak salt solutions which cause distinct plasmolysis (2.5 per cent KNO_3; 1.25 per cent NaCl, etc.) motile bacteria continue to move, often for hours. In stronger solutions (5–10 per cent KNO_3, etc.), the movement ceases in a few minutes owing to the benumbing of the flagella, which, however, are never drawn back into the body of the bacillus, being in this respect quite like the motile organs of the Flagellata and unlike pseudopodia. In salt solutions which do not inhibit growth, but are strong enough to produce rigidity of the flagella, these organs continue to be produced. The same is true when 0.1 per cent carbolic acid or picric acid is added. Motility reappears when these inhibitory substances are removed. As in the flagella of the Flagellata the cilia of the Infusoria, and the lashes of ciliated epithelium the movement of the flagella in the bacteria is not independent of the protoplast, but nevertheless continues when the latter is disturbed by plasmolysis. Apparently, as in case of crushed infusoria a small fragment of the protoplast remaining attached to the base of the flagellum is sufficient to continue the movement. Rigidity of the flagella can be brought about in various ways—lack of oxygen, acid reactions, too much salt, mal nutrition, or the addition of poisons. On removal of these injurious influences the motility returns. In case on non-motile cultures of the hay bacillus the addition of ½ per cent asparagin sufficed to induce motility quickly. In the making of cover-glass preparations various changes may take place in the flagella, they may be thrown off, or inrolled, or become swollen so as to be unstainable and unrecognizable. The inrolled flagella never unroll. They often appear as little foamy heaps of rings around the bacteria (typhoid bacil-

lus, hay bacillus, etc.) When the bacillus dies the flagella loose their power of swelling. The flagella often remain till the last, i. e., after the membrane and contents of the bacillus has disappeared. This ready swelling which is always at right angles to the long axis, makes the flagella in stained preparations always thicker than natural. The sprouting of the flagella from the body of the cell and their subsequent increase to full length consumes sufficient time so that its phases can be fixed and studied. In *Spirillum undula* it takes place before completed cell-division and from that end of the cell previously destitute of flagella. Continued cultivation in strong salt solutions, e. g. 4 to 5 per cent NH_4Cl, prevents motility, but does not interfere with the formation of the flagella. By movements of neighboring bacilli the flagella are often twisted into strands which are sometimes very large.

In *Bacillus subtilis* the spore is generally found in non-flagellate rods forming the pellicle, rarely in free swiming flagellate rods. The flagella of bacteria are not drawn back into the cell during spore formation. Involution forms of *Bacillus subtilis* bear no flagella, but in the involution forms of some other bacteria they are not thrown off. All motile bacteria possess flagella, and these are the sole organs of movement. Flagella are polar or diffuse according as they are restricted to one end of the cell or occur on any part of it. Polar flagella vary in number from one to several, and this number is characteristic for different species, except when the cells are dividing polar flagella are always at one end. The flagella of the bacteria are neither threads of protoplasm which can be thrust out and drawn back, nor dead appendages of the membrane moved by the protoplast. The substance of the flagellum possesses a life of its own, and the power of swelling and self-contractility. With the protoplast, of which they are a part, the flagella appear to be only loosely connected, yet the little protoplasmic remnant which in plasmolysis often remains attached to the base of the flagellum, and sometimes connects it with the shrunken protoplast is certainly to be regarded as a sign of such morphological union. In connection with the physiological diagnosis of the bacteria a morphological basis for classification is to be sought, and this the author thinks he has found for the rod-shaped bacteria in the number and position of the flagella and the shape of the spore-bearing cells. The author's classification is probably a step in the right direction, and will certainly lead to renewed efforts to determine the number and position of the flagella on a great variety of microörganisms, but, in the present state of our ignorance, it cannot be considered anything more than tentative. It ought not to be adopted until it has been tried thoroughly to see

whether it has in it the elements of permanency. It is novel to say the least to find numerous genera established on purely theoretical grounds with no known forms to put into them. In Dr. Fischer's classification the bacteria are divided into two orders: The Haplobacteriaceæ, or single celled bacteria, and the Trichobacteriaceæ, or thread-form bacteria (*Cladothrix*, etc.). The former multiply by slight elongation and cross-septation, the cells separating or remaining attached in small numbers. The latter consist of long cells, branched or unbranched, which finally break up into conidia or motile segments. The Haplobacteriaceæ consist of Coccaceæ, Bacillaceæ, and Spirillaceæ. The author's classification of the more difficult group is as follows:

Family Bacillaceæ.

Vegetative body one-celled, straight, with a distinct longitudinal axis, varying from short ellipsoidal to elongated rod form. Division always at right angles to the longitudinal axis; motile or non-motile; occuring singly or in chains; bearing endospores or arthrospores.

1. Sub-Family Bacillei.

Non-motile, destitute of flagella.

(a) With endospores.

(1). Bacillus (Cohn).	Spore-bearing rods cylindrical.
(2). Paracloster (nov. gen.)*	Spore-bearing rods fusiform.
(3). Paraplectrum (nov. gen.)*	Spore-bearing rods clavate.

(b. Without endospores, with arthrospores).

(4). Arthrobacter (De Bary).*	

2. Sub-Family Bactrinei.

Motile, with a single polar flagellum.

(1). Bactrinium (nov. gen.)	Spore-bearing rods cylindrical.
(2). Clostrinium (nov. gen.)*	Spore-bearing rods fusiform.
(3). Plectrinium (nov. gen.)*?	Spore-bearing rods clavate.
(4). Arthrobactrinium(nov. gen.)*	With arthrospores.
(5). Chromatium.	Red sulphur bacteria.

3. Sub-Family Bactrillei.

Motile rods with a tuft of polar flagella.

(1). Bactrillum (nov. gen.)	Spore-bearing rods cylindrical.
(2). Clostrillum (nov. gen.)*	Spore-bearing rods fusiform.

(3). Plectrillum (nov. gen.)* Spore-bearing rods clavate.
(4). Arthrobactrillum (nov. gen.)* With arthrospores.

SUB-FAMILY BACTRIDEI.

Motile, with diffuse flagella.
(1). Bactridium (nov. gen.) Spore-bearing rods cylindrical.
(2). Clostridium(Prazm. *pro. parte.*) Spore-bearing rods fusiform.
(3). Plectridium (nov. gen.) Spore-bearing rods clavate.
(4). Diplectridium (nov. gen.) Spore-bearing rods dumb-bell shape.
(5). Arthrobactridium (nov. gen.)* With arthrospores.

According to the author, 8 or nearly one-half of these so-called genera are founded on purely theoretical considerations, while there is some doubt as to whether there are any known species to go into two others. These pseudogenera are here indicated by asterisks.

—ERWIN F. SMITH.

The Mushroom Gardens of South American Ants.—Ever since the appearance of that wonderfully interesting book, The Naturalist in Nicaragua, it has seemed probable that the leaf-cutting ants do actually grow fungi for food, and use the countless thousands of leaf fragments which they drag into their nests for the same purpose that a gardener uses dung. Belt ascertained that the leaves were never used for food, found the fungus in every nest, observed the solicitude of the ants when it was disturbed, and in various particulars carried his inquiry as far as it was possible to do by simple observation. It remained for Alfred Möller, a young German, the nephew of Dr. Fritz Müller, and the pupil of Dr. Oscar Brefeld, not only to confirm Belt's surmise by close observation and exact experiment, but also to add greatly to our knowledge of the habits of these curious little gardeners and of the nature of the fungi they cultivate. These observations and experiments are embodied in Die Pilzgärten einiger südamerikanischer Ameisen (pp. VI, 127, Figs. 4, Pl. VII), which forms the 6th part of Professor Schimper's *Botanischen Mittheilungen aus den Tropen*, Jena, 1893. Möller's observations were made at Blumenau, Brazil, where he remained two years. The journey was made under the auspices of the Royal Academy of Sciences, of Berlin, whose wisdom in making this expenditure of a few thousand marks has certainly been more than justified by the outcome. During the course of the investigation several hundred ant nests were examined, these ants belonging to three genera, viz.: Atta (4 sp.); Apterostigma (3 sp.), and Cyphomyrmex (2 sp.) All are zealous cultivators and eaters of fungi, but the ants of

each genus grow a different sort, one kind only, and stubbornly refuse to eat any other, preferring to starve. More curious still, under the zealous attention of these little gardeners a special form of the fungus has been developed in much the same way that human selection has developed choice cabbages and cauliflowers out of what were originally quite ordinary sorts. This form of the fungus consists of groups of swollen hyphæ-ends, called Kohlrabi tufts. The greater part of the book deals with the fungous gardens of species of the genus Atta. The garden occupies the center of each nest as a loose, sponge-like mass, consisting of leaf-fragments held together by fungous threads. These gardens are often of large size, but between them and the walls of the nest there is always an open space. In the sponge-like cavities of these gardens the ants live, place their eggs, and rear their young. Often the eggs and sometimes the larvæ are overgrown and fastened together by the fungus, so that many as a hundred eggs may be seized and carried away by a single ant without inconvenience. The well known care that ants bestow on their progeny makes it certain that this placing the eggs in groups and allowing them to be bound together by the fungus is not simply accidental. When the nest is broken open and its contents scattered, or when the colony migrates, every tiny fragment of the fungous garden is gathered up and removed as carefully, and with as much solicitude as are the young. These fragments are rapidly and skillfully built into a new garden in the old nest or in some other place. Leaves are cut from a great many sorts of plants and often in such quantities as to entirely defoliate them, but are never eaten even to prevent starvation. Their sole food is the fungus which they cultivate, even fruits and starchy foods being used exclusively as a substratum for growing this much-beloved fungus. The leaf fragments brought into the nest are bitten and trimmed into smaller pieces and these are squeezed and kneeded into tiny pellets which are then carefully patted into the walls of the garden, and are overgrown by the fungus in a few hours. Exhausted fragments are thrown out and fresh pellets put in wherever needed by the fungus. Old worn-out masses of mycelium are also thrown out of the nest. Upon a special class of the colony, distinguished from the leaf cutters by their smaller size, devolves the task of weeding the garden and keeping it pruned within bounds. When neglected for a single day, i. e., by the removal of most or all of the ants, innumerable fungous threads shoot out into the air in every direction, and the well-kept garden soon becomes an unmanagable and uninhabitable thicket. When only a few ants are left in such a nest they work desparately, night and day, to keep it in order, but seem to know

that something is wrong, and are finally driven out by the too luxuriant growth of their own culture plant, being compelled to seize their young and flee for very life in a comical way. Most remarkable of all, especially to one who has busied himself much with trying to make and keep pure cultures of various fungi, is the ability of these ants to keep their gardens free from bacteria and all sorts of intruding fungi. Cultures made from various parts of a great many gardens showed conclusively that in an overwhelming proportion of cases these gardens are pure cultures of a single fungus. Unquestionably the ants must be constantly busy with the destruction and removal of intruding organisms. The Kohlrabi, or specially developed bunches of swollen hyphæ ends, occur as minute glistening rounded specks on all parts of the garden and are eagerly devoured by the ants. Unswollen, long mycelial threads push out into the air from all parts of the garden as soon as the ants are removed, and finally bear two kinds of conidial fruits, but nothing of the sort occurs while the ants are in undisturbed possession, and it is pretty certain that they must keep these undesirable shoots in check by constant biting, although this was not observed. The two kinds of conidial fruits were also obtained from artificial cultures under special conditions. In rare cases (only 4 were observed) the fungous garden pushes up through the top of the nest and fruits in the open air, this form of fructification being a large, flecked, wine-red, Amanita-like Agaricus, named by the author *Rozites gongylophora*, and never found except on the ant nests, rooted in the fungous garden. Pure cultures in great numbers and numerous microscopic observations proved beyond reasonable doubt that the swollen hyphæ, and the various kinds of fructification belong to one and the same fungus, and establish for the first time the existence of true conidia in the Agaricineæ. The ants of the other two genera, while equally diligent cultivators of fungi, build much smaller nests and are not leaf cutters, but use fragments of wood, dung, etc., as a substratum for their gardens. The fungi cultivated by them are believed to be hymenomycetous, but each genus has a different species. The different species of these ants vary in ability as gardeners. The facts set forth in this book were derived from prolonged examination of the ants in the open and in captivity, and by hundreds of patient and painstaking cultures and microscopic studies, and appear to be worthy of full credence. Mr. Möller's persistent and painstaking method of work is especially commendable to those over-ambitious young men who are content to look into the microscope one day and publish the next.

NOTE. Since this was written Mr. W. T. Swingle has discovered that our own *Atta tardigrada* has the same habits as its South American relatives, Several fungous gardens have been taken from nests near Washington, and the writer has seen beautiful Kohlrobi tufts growing on the dung of leaf-eating insects. ERWIN F. SMITH.

ZOOLOGY.

Irish Fresh-Water Sponges.—In a recent number of the *Irish Naturalist* (Vol. iv, pp. 122–131), Dr. R. Hanitsch enumerates six species of Spongillidæ from Ireland, the "British fauna" containing but four species. Three of these occur in Ireland, the other three sponges, all from the west coast of the latter country, being also North American species. Dr. Hanitsch would not solve this interesting distributional problem by supposing a former extension of the sponges over the whole northern hemisphere; he believes that their gemmules could readily have been carried across the Atlantic by winds, ocean currents, or birds. In some remarks on the European distribution of the Spongillidæ, Dr. Hanitsch notices their extreme rarity in southern Europe. Only one species is known from the Iberian peninsula (N. Portugal), two from the Italian, while none at all have been found in the Balkan. (Natural Science, July, 1895.)

Reproduction of the Edible Crab.—Through the observations of Mr. Gregg Wilson, some new facts have been brought to light concerning reproduction in the edible crab (*Cancer pagurus*) of the Northumberland coast, England. Crabs that have recently cast their shells have pale ovaries that show no development of ova to the naked eye. Hard crabs have brilliant orange or scarlet ovaries, with ova distinctly visible. Both lots are taken in the catch from October to February. Spawning seems to take place only every second year of the crab's life. At no time were ova undergoing segmentation found within the crab, so that the old idea that fertilization is internal must be abandoned. Milt is undoubtedly passed by the male crab into the body of the female, but it does not affect the roe before extrusion. It is received in flask-shaped *receptacula seminis*, that open off the oviducts quite near the genital apertures. They are well-valved and seem to retain the motionless spermatozoa for long periods. Spawning was noticed to

take place during November, December and January. The author is inclined to think that there is a migration connected with either the spawning act or the hatching out of the ova. The mature female crab is usually 6½ inches in size, while males, are mature when much smaller. (Proceeds. Roy. Soc., Edinburgh, Vol. XX).

The Odonata of Lower California.—Various collections of Dragon-flies from Baja California have been acquired from time to time by the California Academy of Sciences, and these form the basis for a memoir recently published by Dr. Philip P. Calvert. The total number of specimens examined is 2600, representing 40 species, of which 6 are new. Of these species, 9 are distributed over a considerable part of temperate America; 18 are neotropical, and 18 nearctic in distribution, while 3 of the species described as new are, according to present knowledge, restricted to Lower California. One of the objects of the paper is to determine the amount of variation in structural details, especially in the venation of the wings, assumed to be of generic character. These variations are to be found under the respective species.

Three page plates, containing 123 figures, accompany the descriptions of the species. (Proceeds. Cal. Acad. Sci. (2) IV).

Baur on the Temporal Part of the Skull,[1] and on the Morphology of the Skull in the Mosasauridae.[2]—In the first paper Dr. Baur reviews the work which he has done in the difficult analysis of the temporal region of the reptilian skull, in former years, and what has been done since by other authors. His results may be summed up as follows. The question relates principally to the determination of the three elements that connect the quadrate bone with the skull superiorly and anteriorly. These have usually, says Baur, been termed the squamosal, supratemporal, and quadratojugal. He adopts this nomenclature for the first and third, but wishes to replace the second by "prosquamosal" of Owen. This is because the name supratemporal was used previously for a different element peculiar to the Teleostomous fishes. The present reviewer has called the three bones in question, the paroccipital, supratemporal, and zygomatic, after earlier authors. Baur maintains that the element which he,with some other authors calls the squamosal, is not homologous with the paroccipital of the tortoises and Ichthyosaurs, as I have supposed. He agrees with those au-

[1] Remarkungen ueber Die Osteologie der Schläfengegend der höheren Wirbelthiere. Anatomischer Anzeiger, X, 1894, p. 316.

[2] The American Journal of Morphology 1894, p. 1.

thors who think that the paroccipital of the Squamata, Crocodilia, etc., is fused with, and undistinguishable, in the adult skull, from the exoccipital. As proof that this is the case, he cites the opinion of various authors, and especially that of Hallmann, who, he alleges, demonstrated this to be the fact in 1837. On this essential point it may be remarked, first, that most of the authors cited have simply supposed this to be the case without making any attempt to demonstrate it. Second, although I have repeatedly examined crania of lizards from the first appearance of ossification, I have never observed a distinct center in the position of the paroccipital of tortoises and which Hallmann and others regard as the representative of that bone; nor have I observed it in the Crocodilia. W. H. Parker has not seen it, nor does Baur say he has done so. After having announced his discovery of it in Sphenodon, he afterwards changed his mind and concluded that he had been misled by appearances. Until the presence of such an element in the Squamata is demonstrated, I must continue to regard the element called by Baur in that order, the squamosal, as the paroccipital. In the Mosasauroids the element has more nearly the position of the paroccipital of tortoises than in any other of the Squamata. I may say that I have not been able to see Hallmann's memoir, and that I am entirely open to conviction when the evidence shall be produced, though I suspect that it will not be forthcoming.

In stating his disagreement with my conclusion on this point, the author does not make it clear that he has come to agree with me in two points on which we formerly differed. Thus he now agrees with my view of 1871, that the single postorbital bar of the Lacertilia is homologous with the superior bar of Sphenodon, and not the inferior, as he has recently maintained, though he at one time agreed with me. He also agrees that the suspensorium of the quadrate of the Ophidia is the paroccipital (squamosal Baur), and not the supratemporal (prosquamosal Baur); an opinion in which I have been alone hitherto.

If the element which I have identified with the paroccipital in the Squamata, is not that element, it is not thereby proven that it is identical with the squamosal of the Mammalia. Moreover it cannot be homologous with the element in the Ichthyosauria, Cotylosauria and Stegocephalia with which Baur identifies it, since it is a brain-case bone, while the latter is a temporal roof-bone, a fundamental difference. For this reason I have called the latter the supramastoid. (See my paper on the Transactions of the American Philosophical Society, 1892, p. 11).

The student who desires to become acquainted with the opinions of authors on the points involved, cannot do better than consult Dr. Baur's paper. His references to the literature are full, and his method in this respect is a model worthy of imitation.

Having seen that Dr. Baur now agrees with me that the bone which supports the quadrate in the Ophidia is not the supratemporal (prosquamosal) I will take up his older, but above last-mentioned paper on the Pythonomorpha. Like Owen, Marsh and Dollo, he does not perceive that this group is essentially distinct from the Lacertilia, and concludes with them that I have erred in alleging it to present affinities to the Ophidia. He places it in the order Lacertilia and in close proximity to the Varanidæ as did Cuvier.

In order to determine this matter, it is necessary to know, in the first place, what the characters are that distinguish snakes from lizards. The superficial characters given by systematic writers generally as distinguishing the Lacertilia and Ophidia, are quite insufficient for that purpose. Johannes Müller[1] first placed the distinction on a sound basis by showing that in the Ophidia the frontal and parietal bones descend to the basicranial axis as in no other vertebrates, thus closing the brain case in front, while in the Lacertilia this does not occur, and as the ali- and orbitosphenoid bones are rudimental or wanting, the brain case is without osseous wall in front. Some lizards present a distinct approximation to the Ophidian type in the strong decurvature of the parietal bones at the sides: these are the Annulati and the Anniellοidea. These groups display a similar approximation in the continuous sutural union of the occipital and parietal elements, a condition universal in Ophidia, and rare in Lacertilia.

I have pointed out[2] another distinction between the two divisions, viz., that the supratemporal ("squamosal," "prosquamosal") is present in the Lacertilia and absent in the Ophidia. As it is, however, absent in the Annielloidea and Amphisbænia, I have not included it in the definition of the former suborder. This definition has not been adopted by those authors who erroneously regard the suspensorium of the quadrate bone in the Ophidia as identical with the supratemporal of the lizards, but my view has now received the assent of various anatomists, as e. g., Prof. Baur.

A third distinction is that the quadrate bone is supported by the paroccipital in the snakes, and the exoccipital in the lizards. Baur

[1] In Tiedmann u Treviranus Zeitschrift f. Phisiologie, IV, 233.

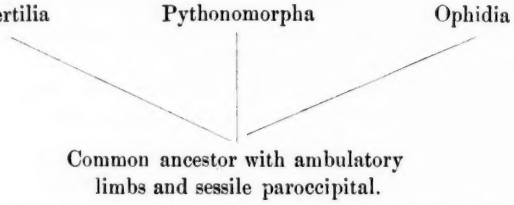
[2] Proceeds. Amer. Assoc. Adv. Sci., 1871, p. 221; Trans. Amer. Philos. Soc., xiv, 1869, p. 29.

and some others do not, however, agree that the suspensorium in the snakes is the paroccipital, but call it squamosal and other names. I was led to identify it with the former element of the Testudinata, etc., by a consideration of its structure in the Pythonomorpha,[3] where it is much more largely developed than in the Lacertilia, and where it supports the quadrate bone as in the Ophidia. The accompanying figures make this more clear. The paroccipital bone is received deeply between the exoccipital and the petrosal in the Pythonomorpha in the same manner as in the Tortricine snakes; a structure which does not occur in the Lacertilia. This structure is somewhat masked in some genera of Pythonomorpha by the extension of the exoccipital over the paroccipital as a thin lamina on the posterior side; in that case its true relation to the petrosal can be seen on the anterior side. In the Lacertilia the quadrate merely touches the paroccipital bone, whose distal end has a *convex* surface (Figs. 1, 1a), but it articulates with the exoccipital bone. This it never does in the Ophidia and Pythonomorpha. This is a fundamental difference between Lacertilia and Pythonomorpha to be added to those which I have already given.

For this reason, and in view of the various important differences from the Varani, it is necessary to believe that the Pythonomorpha form a line distinct from the Lacertilia, and that their resemblances to the Varani are the result of a parallel evolution rather than an indication of near affinity.

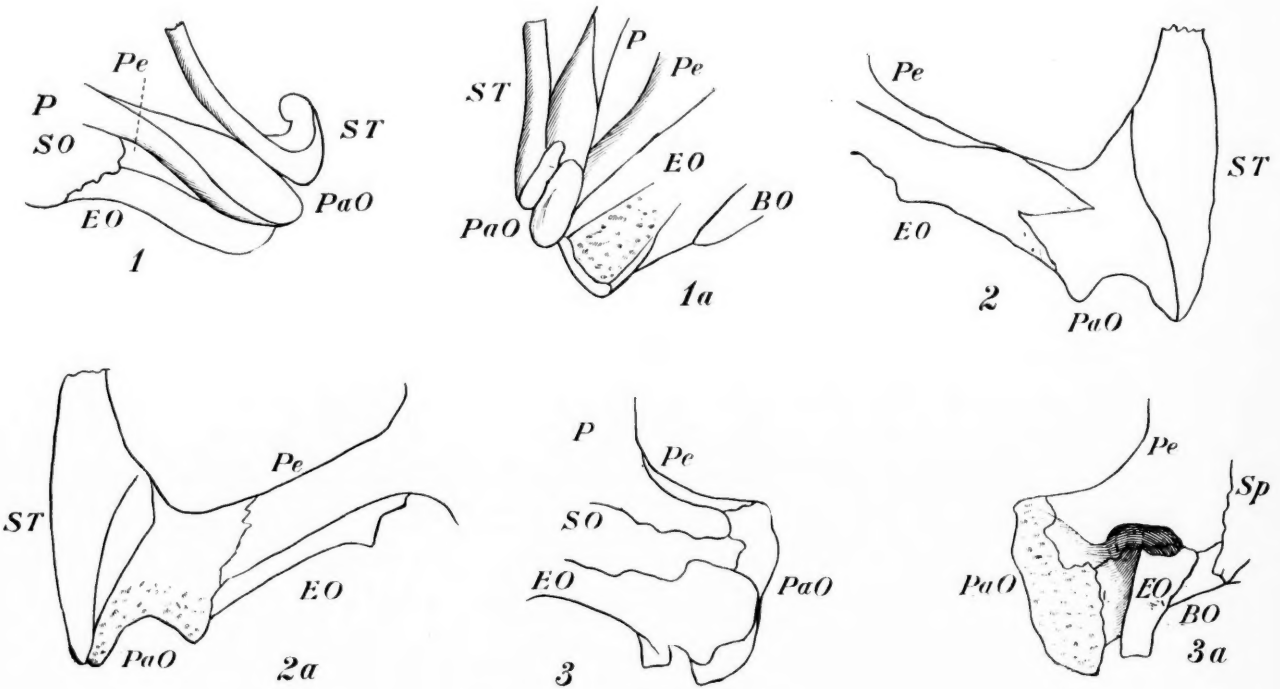
The failure of Cuvier, Owen, Dollo, Baur and Marsh to perceive this fact is due to their want of information as to what the differences between the Ophidia and Lacertilia really are.

From this point of view the Ophidia and Pythonomorpha must be traced to some type in which the paroccipital bone is less remote from the brain case than is seen in the Lacertilia, where it has become a mere rudiment. Such a phylogeny could be expressed as follows. An investigation of ths Dolichosauria of the Cretaceous might yield interesting results.



[3] L. c., and the Cretaceous Vertebrata of the West, U. S. Geol. Surv. Terrs, Vol. II, 1875.

PLATE XXXI.



Suspensoria of Reptilia Squamata.

The characters of the three suborders of the Squamata are then as follows:

Quadrate bone articulating with exoccipital; paroccipital external to bones of brain case; parietal bones not closing the brain case in front; generally an epipterygoid and sternum; teeth with dentinal roots; phalanges with condyles; *Lacertilia.*

Quadrate bone articulating with paroccipital, which is embraced by bones of brain case; parietal bones not closing brain case in front; epipterygoid and sternum present; teeth with osseous roots; phalanges truncate; *Pythonomorpha.*

Quadrate bone articulating with paroccipital; parietal and frontal bones closing brain case in front; no epipterygoid or sternum; teeth rootless; no phalanges; *Ophidia.*

I cannot agree with Boulenger that the Chamæleontidæ represent a division of equal rank with these three, as most of the characters may be found in one Lacertilian or another, and the group is in many ways related to the Agamidæ of the Pachygloss division. For me it represents a superfamily for which the name Rhiptoglossa is available.—E. D. Cope.

Explanation of Plate.

Views of suspensoria of quadrate bone of Squamata. 1. *Varanus griseus* from above; *b*, from below and forwards. 2. *Mosasaurus dekayi* from above; *b*, from below. 3. *Ilysia scytale* from above; *b*, from below. S O, supraoccipital; E O, exoccipital; PaO, paroccipital; Pe, petrosal; P, parietal; B O, basioccipital; Sp, sphenoid. The dotted surfaces represent the articular surface for the quadrate.

A New Xantusia.—A specimen sent me by Dr. J. J. Rivers of Berkeley, Cal., taken at Tejon Pass California, indicates a new and handsome species of Xantusia. It is allied to the *Zablepsis henshavii* of Stjeneger (see last number of the Naturalist where the genera of Xantusiidae are defined), but differs in generic characters. It has longer limbs and a longer tail than in either of the Xantusiæ known. The hind leg extended forwards, reaches the shoulder, and the tail is twice the length of the body. There is but one row of superciliary scales, and there is but one frontoparietal on each side. Seven superior labials, not separated by scales from orbit. Four inferior labials, the fourth separated from the third by the large third infralabial, which reaches the lip border. Fourteen to sixteen longitudinal rows on the belly. Ten femoral pores. Color above light reddish-brown, marked

with two or three rows of large maron spots. Head above maron, the plates pate bordered. Inferior surfaces pale reddish-yellow. Dength 124 mm.; of head and body, 51 mm.

This species is nearer to the *X. vigilis* than to the *X. riversiana*, but differs greatly in its proportions, and in numerous details of scutellation and in coloration. It is nearer to the *Zablepsis henshavii* Stjen., but besides the generic characters, that species has a shorter hind leg, a continuous series of lower labials, and a different coloration.—E. D. COPE.

Bats of Queen Charlotte Islands, British Columbia.—During the past two or three years several small collections of bats, numbering in all 12 specimens, have been sent me from the Queen Charlotte Islands. They were obtained at a place called Massett, at the north end of Graham Island, by the Rev. J. H. Keen, and were transmitted through the courtesy of Mr. James Fletcher, of Ottawa. All of these bats belong to the genus *Vespertilio*. They represent three very distinct specific or superspecific types, namely *V. subulatus*, *V. lucifugus* and *V. nitidus*. In each case the specimens differ in color from the typical form, being decidedly blackish instead of brownish. The ears, feet and membranes, are nearly black, and the color of the fur is very dark.

The Queen Charlotte Islands representative of *V. lucifugus* differs further from the typical form (from the eastern United States) in having decidedly larger feet and in the form of the ear conch, which is less emarginate posteriorily. It may be worthy of subspecific recognition.

The representative of the big-eared *V. subulatus* is so different from the eastern animal that I am forced to describe it as new, and in so doing it gives me pleasure to associate with it the name of its collector, the Rev. J. H. Keen. It may be known by the following description:

Vespertilio subulatus keenii subsp. nov.—Type from Massett, Queen Charlotte Islands, B. C.

Type No. 72922 ♀ ad. U. S. National Museum, Department of Agriculture Collection. Collected by Rev. J. H. Keen, in summer of 1894.

General characters.—Similar to *V. subulatus*, but with shorter, narrower wings, and larger ears; color blackish instead of brownish. Ears, feet, and membranes black except the under surfaces of the wing bones, leg bones, and tail vertebræ, which parts are flesh colored. Fur, blackish, slightly washed with brownish. Ears very long: laid forward they

project 3 mm. beyond the nose. Tragus long, slender, and slightly arcuate. Wings attached to feet near base of toes.

Measurements (from alcoholic type (♀ ad.) in good condition).—Total length, 82 mm.; head and body, 42; tail, 41; head, 17.5; ear from inner basal angle, 16; tragus from inner attachment, 8; humerus; 23; forearm, 35.5; thumb, 7; third finger, 57; fifth finger, 46; tibia, 17; foot, 8. C. HART MERRIAM.

Migrations of the Lemming.—A valuable account of "*Myodes lemmus*, its Habits and Migrations in Norway," has been published by Prof. R. Collett, of Christiania. The nature and habits of the lemming are described, and their suicidal migrations discussed on a basis of the author's personal knowledge of the lemming. The migrations seem to be due to over-population. During certain years an abnormal fecundity takes place among these creatures, and the consequences of this multiplication is given by the author as follows:

"The enormous multitudes require increased space, and the individuals, which, under normal conditions, have each an excessively large tract at their disposal, cannot, on account of their disposition, bear the unaccustomed proximity of the numerous neighbors. Involuntarily the individuals are pressed out to the sides until the edge of the mountain is reached. In a short time they enjoy themselves there, and the old individuals willingly breed in the upper region of the forests, when, at other times, they are entirely wanting. New swarms, however, follow on; they could not return, but the journey proceeds onwards down the sides of the mountains, and when they once reach the valleys they meet with localities which are quite foreign to them. They then continue blindly on, endeavoring to find a home corresponding to that they left, but which they never regain. The migratory individuals proceed helplessly on to certain death. The writer thinks it probable that the wandering instinct developed in migratory years is of distinct service to the species in reducing surplus population.

The Brain of Microcephalic Idiots.—A paper embodying the results of a thorough examination of the brains and skulls of two typical microcephals, by Prof. D. J. Cunningham and Dr. Telford Smith, has just been published in the Transactions of the Royal Dublin Society. The authors accept the view arrived at by Sir George Humphrey, from the examination of microcephalic and macrocephalic skulls, viz: "There is nothing in the specimens to suggest that the deficiency in the development of the skull was the leading feature in the deformity, and that the smallness of the bony cerebral envelop exerted a com-

pressing or dwarfing influence on the brain, or anything to give encouragement to the practice lately adopted in some instances of removal of a part of the bony case, with the idea of affording more space and freedom for the growth of the brain. In these, as in other cases of man and the lower animals, the brain-growth is the determining factor, and the skull grows upon and accommodates itself to the brain, whether the latter be large or small." (Nature, 1895.)

Zoological News, Birds—During the recent visit of Messrs. Brewster and Chapman to the island of Trinidad, the observations of Mr. Chapman on the song habit of the Rachette Hummingbird (*Pygmornis longuemareus*) were confirmed by the discovery of a locality to which the birds evidently came to sing. This resort was frequented also by *Phaethornis guyi* for the same purpose. The latter, while singing, spreads the tail feathers to the fullest extent, pointing them forward over the back until the tips of the long central feathers nearly touch the back of the head. The effect is most striking, the birds suggesting diminutive turkey-cocks. All the specimens killed at these haunts were males. (The Auk, XII, 1895).

The family name of Macropterygidæ is proposed for the Tree-Swifts of Malaysia, by Mr. F. A. Lucas, instead of Dendrochelidonidae, which is preoccupied. To the differential characters described in a previous paper, the author adds the following three important ones:

	Micropodidae.	*Macropterygidae.*
Hypsotarsus,	simply grooved,	with an tendinal foramen.
Shoulder-muscles,	strictly Cypseline,	Passerine.
Deep Plantars,	strictly Cypseline,	characteristic.

The author states that the differences between the Macropterygidae and other Swifts are as great as those existing between any two families of Passerines with which he is acquainted. (The Auk, Vol. XII, 1895).

ENTOMOLOGY.[1]

Chordeumidæ or Craspedosomatidæ ?—This family of Diplopoda has been classified by different authors under the Iulidæ, Poly-

[1] Edited by Clarence M. Weed, New Hampshire College, Durham, N. H.

desmidæ and Lysiopetalidæ,[2] but if we acknowledge its distinctness a choice is still necessary between the names mentioned in the heading.

The weight of more recent usage is clearly on the side of "*Chordeumidæ*," indeed this name seems to have been almost exclusively employed since it was taken up by Latzel in his great work on the Austrian Myriapoda (1884), after having been entirely disregarded since its publication by C. L. Koch (1847).[3] The alternative is thus between ten years of usage or five years of priority.[4] For those of us who may have used "*Chordeumidæ*" on the supposition that Latzel must have had some good reason for neglecting an earlier name, it may save the trouble of reference to a comparatively rare book to state that in Gray's arrangement "Fam. 2 *Craspedosomidæ*" includes the four genera Craspedosoma Leach, Cylindrosoma Gray, Reasia Gray, and Cambala Gray, in the order named. Evidently the author did not base his family on characters now recognized as important, but no more did Koch, who included in "*Chordeumidæ*" Campodes and Callipus, members respectively of the Iulidæ and Lysiopetalidæ.

It would seem that there was less warrant for Latzel's course from the fact that Humbert and Saussure had recognized and described[5] the family "*Craspedosomidæ*," though still including the Lysiopetalidæ as one of two tribes or sub families; indeed, it is entirely possible that the preference for "*Chordeumidæ*" was merely on the ground of brevity. There is, at least, ample justification for such a supposition in the fact that Latzel had previously changed the names of the families Pauropodidæ and Eurypauropodidæ, alleging as a reason the similarity of the former with the ordinal name Pauropoda, and the "horrible difficulty of pronunciation" of the latter. Priority aside, these reasons seem hardly sufficient to justify such family names as "*Pauropoda agilia*" and "*Pauropoda tardigrada*," which Latzel offers as substitutes. But even if the improvement had been more marked there must still

[2] Iulidæ: Leach, Berlese.
Polydesmidæ; Newport, Gervais, Porat, Meinert.
Lysiopetalidæ: Wood, Cope, Harger, Ryder, Packard.

[3] System der Myriapoden, pp. 49 and 119.

[4] The family "Craspedosomadæ" was published by J. E. Gray in the article on Myriapoda by T. Rymer Jones, in Todd's Cyc. Anat. and Physiol., III, p. 546 (1842). The author of the article specifically states that the arrangement of the Myriapoda there proposed was the work of Gray, published from his manuscripts and with his consent. Hence there is no apparent reason for citing the authority of Jones as Latzel and others have done.

[5] Rev. et. mag. d. Zool. 2d series, XXI, p. 153 (1869).
Mission Scient. au Mexique, Zool. VI, 2, p. 56 (1872).

be grave doubts of the advisability of changing family names whenever more brief or euphonious substitutes are offered. True, the winding polysyllables seem a useless infliction, and doubtless frighten many short-breathed people away from scientific study; but if there had been no dodging on "*Craspedosomatidæ*," it might have stood as a warning which should have saved us such names as Paradoxosomatidæ, Archispirostreptus, and Pseudonannolenidæ. These are longer than the pre-Linnean descriptions, and may further endanger the popularity of the binomial system, already threatened in other ways.

Let us hope that before the nomenclatorial agitation entirely subsides, we may have a rule limiting scientific names to reasonable length. Their authors might then have the time and strength to make a serviceable description, possibly a plate! If this suggestion is not received favorably by the "cloth" it will be quite easy to secure enough "lay" votes to pass it by large majority. —O. F. Cook.

On the Generic Names Strigamia, Linotænia and Scolioplanes.—The genus *Strigamia*, was proposed by Gray, in 1842, in the article by T. Rymer Jones, in Todd's Cyclopædia, as cited in the preceding note. The description is as follows:

"Gen. H. Strigamia (*Geophilus*). Eyes none, antennæ 14-jointed, moniliform, rather elongate. Body linear, depressed. Feet, fifty pairs or more."

It is significant that *Strigamia* stands as the fourth genus of the Scolopendridæ, the other three being Lithobius, Scolopendra and Cryptops. The most natural inference from the above quotation is that Gray for some reason preferred *Strigamia* to Geophilus. This seems to have been Latzel's idea, for he places *Strigamia* Gray, as a doubtful synonym under Geophilus. Whatever may have been the intention of Gray, however, there would seem to be an insurmountable obstacle to the use of his name, in the fact that he published no species under it, the case not being parallel with that of Fontaria. Neither is there any mention of a species of *Strigamia* in what purport to be complete lists of the Chilopoda of the British Museum. Indeed, in the list of 1856, in the preparation of which Gray himself assisted, *Strigamia* appears only as a synonym of Geophilus! It should have rested quietly there, but names were too scarce, and so *Strigamia* was again brought out by Wood, in 1865, and applied to *Geophilus* Newport, not Leach. The type of Geophilus Leach, is *carpophagus*, but this species had been sequestrated by Newport and put into a new genus, *Arthronomalus*, leaving *Geophilus* as the name of another genus whose type was *acuminatus*,

Leach. Thus Wood's proposition was to assign to *Strigamia* a type species *acuminatus*, and Latzel is in error in citing *Strigamia* Wood, as a synonym of Geophilus. If we allow that aborted names and synonyms can be thus resuscitated, *Strigamia* Wood, must have stood as a valid genus had it not been for the fact that C. L. Koch had in 1847 established the genus Linotænia on *Geophilus crassipes*. C. L. Koch, a congener of *acuminatus*, so that *Strigamia* Wood is a synonym of Linotænia C. L. Koch.

Neglecting the claims of Linotænia, Bergsoe and Meinert, in 1866, described *Scolioplanes* on *Geophilus maritimus* Leach, also congeneric with *acuminatus* and *crassipes*. The only ground on which *Scolioplanes* could be considered valid is that Linotænia as described by Koch was not a natural group, but this criticism would destroy a large majority of the older genera. It may be that the establishment of *Scolioplanes* was wise at the time, for the identities and relationships of even the European Geophilidæ were uncertain. At present, however, the European authors seem to be agreed that *acuminatus*, *crassipes* and *maritimus* are members of one genus, and while this view is held it would seem that the genus must stand as Linotænia C. L. Koch, with *Scolioplanes* Bergsoe, and Meinert as synonym.

Still another complication has been introduced by Sseliwanoff.[6] He uses *Scolioplanes* Bergsoe and Meinert, but recognizes *Strigamia* Gray as distinct, describing it at length and giving figures of *Strigamia parviceps* Wood, from California, also placing *Strigamia* Wood as a synonym of *Strigamia* Gray. To judge by the descriptions and diagrams of Meinert, Latzel and Daday, the European species as represented by *crassipes* are to be distinguished from *parviceps* by apparently good generic characters. That the American forms which have been referred to *Strigamia*, *Scolioplanes* and *Linotænia* are all congeneric is improbable, but Sseliwanoff has assumed the responsibility of separating *parviceps* and its allies from Linotænia (*Scolioplanes*), and his distinctions should not be ignored, even if *Strigamia* is no longer available as a generic name.

Dissections of *Strigamia bothriopus* Wood, *S. chionophila* Wood, and *S. parviceps* Wood, show that the mouth-parts of all three are very much alike, and that they differ from Linotænia in having the labial sternum divided, and the labial palpus two-jointed, the basal joint with a process, as in Sseliwanoff's figure of *parviceps*. Hence it seems probable that the other American species are more likely to be related to a genus

[6] Geophilidæ museja imperatorskoi Akademii Nauk, p. 12 (1881). T. I., figs. 1–8.

founded on *parviceps* than to the European genus Linotænia.

It is proposed, then, to end, if possible, the confusion which has long attended the use of these generic names by the following arrangement of synonomy:

Genus Geophilus Leach (1814), type *carpophagus* Leach.
Syn. *Strigamia* Gray (1842), no type.
Syn. *Arthronomalus* Newp. (1844), type *longicornis* (Leach).
Genus Linotænia C. L. Koch (1847), type *crassipes* (C. L. Koch).
Syn. *Strigamia* Wood (1865), type *acuminatus* (Leach).
Syn. *Scolioplanes* B. & M. (1866), type *maritimus* (Leach).
Genus Tomotænia nom. nov.
Syn. *Strigamia* Ssel. (1881), type *parviceps* (Wood).

The genus Linotænia is distributed over Europe and Northern Asia. The species are: *acuminatus* (Leach), *crassipes* C. L. Koch, *maritimus* (Leach), *pusillus* Ssel., *sacolinensis* (Meinert), *sibiricus* (Ssel.), *sulcatus* Ssle.

The genus Tomotænia, including species which must be provisionally referred to it, is distributed over temperate North America. The genera of Chilopoda, however, do not appear to be confined by continents, so that a further modification of generic lines and distribution is to be expected. The species which, pending further investigation, should be referred to Tomotænia are: *bidens* (Wood), *bothriopus* (Wood), *branneri* (Bollman), *chionophila* (Wood), *exsul* (Meinert), *fulva* (Sager), *lævipes* (Wood), *longicornis* (Meinert), *maculaticeps* (Wood), *parviceps* (Wood), *robustus* (Meinert), *rubra* (Bollman), *walheri* Wood.

—O. F. Cook.

Picobia Villosa (Hancock).—A response to Mr. E. L. Trouessart. In the April number of The American Naturalist, p. 382–384, I described and figured "a new trombidian" under the above name. In a more recent issue of the same magazine, July, p. 682–684, Dr. E. L. Trouessart, of Paris, takes exception to the species claiming it to be a form of Cheyletinæ, already well known in Europe, not differing from *Syringophilus bipectinatus* Heller. This writer has contributed some valuable articles upon the Acarina with which I was perfectly conversant at the time, notwithstanding he says I was "not acquainted with the modern literature on this interesting type." Thinking it necessary to mention only those papers which bore a classical relation to the species described, these were omitted. In adopting the genus Picobia, I was not alone, for there are others who dissent from the classification Mr. Trouessart lays down, notable among these being Newman,[7] who

[7] Treatise on Parasitic Diseases, p. 235, 1892.

maintains, that "the cheyletinæ, parasites of birds, comprise the genus Cheyletus, Harporhynchus, and Picobia; and in regard to Heller's genus, Syringophilus, the same writer says, p. 236, "for these Acarina he (A. Heller) created the genus Syringophilus which evidently enters into the genus Picobia, and he has described two species in it which ought to be named *Picobia bipectinata* and *P. uncinata*." The various immature stages and the unsettled condition of this group of Acarina, together with an almost total absence of American literature has made it an unusually difficult field for students taking up this line of work. However this may be, we are thankful for the timely discussion, or I may say criticism, raised by Mr. Trouessart on my species, and the expression of his views upon a subject which he is conceded to be an eminent authority. If the form *Picobia villosa* from the black flycatcher is what he claims namely: The same as the European species above mentioned, we are pleased to have the matter straightened, also the point emphasized of the caution necessary in presenting as new, immature stages of these Acarina, sometimes so very different from the adult, and with shades of individual differences, even from localities as widely separated as Europe and America. —Dr. J. L. Hancock.

Chicago.

EMBRYOLOGY.[1]

Conjugation in an American Crayfish.—The following observations upon the breeding habits of *Cambarus affinis* show how much difference there is between the American crayfish and the European form, Astacus, and serve to clear up some important structures of hitherto unknown use.

Some specimens brought from Washington, D. C., in November, 1894, immediately united in pairs when put into a shallow vessel of water. The same specimens and also others received in February paired during February, March and April. About a dozen cases were carefully observed with the following results:

In captivity the entire process of conjugation lasts from two to ten hours and may be repeated by either animal with some other.

[1] Edited by E. A. Andrews, Baltimore, Md., to whom abstracts, reviews and preliminary notes may be sent.

When a male is put into a vessel with a female he seems ere long to become aware of the presence of the female and does not act as he does when males only are present. The female generally retreats and may even resist the attacks of the male, but generally this is not done with much vigor, and very soon after being seized by the male the female passes into a state of passivity, resembling death. The male advances eagerly to the female and grasps her with his large claws, sometimes gently. When the female struggles to escape, the male holds very firmly by one of his claws that grasps a claw, or an antenna, or any projecting part of the head region of the female, and eventually succeeds in turning her upon her back; if there is no struggle, the same result is also accomplished more directly and methodically. The male now seizes all the claws of the female in his two large claws, three in each on each side and holds them firmly as seen in Figs. 1 and 2. He

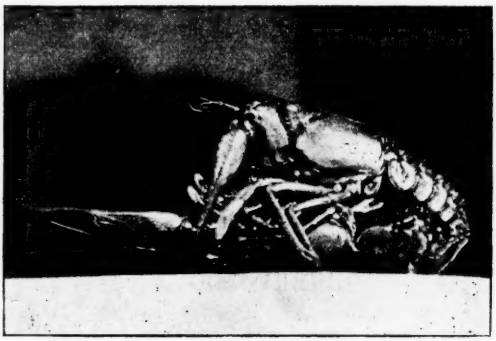


FIG. 1.

moves forward over the supine female into the position shown in the figures. This process has lasted ten to twenty minutes. It is followed by a most unexpected move: the male stands up away from the female, holding the claws as before, and deliberately passes one leg across under his body so that it projects from the opposite side. He then settles down again close to the female. The leg that is passed over is one of the fifth, most posterior, pair of walking legs. In the figures it is the left leg; it seems to be absent on the left side, Fig. 1, but projects straight out and backward between the fourth and fifth on the right side, Fig. 2. In many cases the right leg is used: in one case the leg projected between the third and fourth instead of between the fourth and fifth as usual.

This unusual position of the leg secures the proper position and direction of the intromittent organs. These are the first and second pairs of pleopodes, or abdominal appendages. They normally lie forward in a horizontal groove beneath the thorax, but now they are depressed at an angle of about 45°, and are held so by the transversely placed leg, as may be seen from Fig. 1, which shows the white tips of the intro-

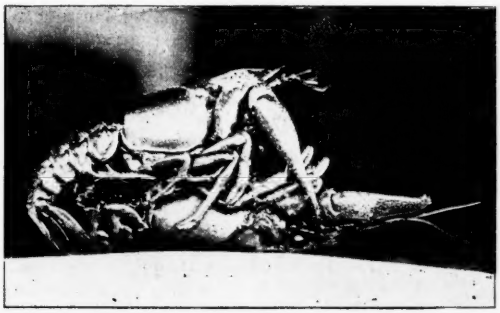


FIG. 2.

mittent organs of the left side. When the organs are thus held they may accomplish their purpose, which is to transfer the sperm to the *annulus* of the female.

As seen in Fig. 2 the abdomen of the female is bent up, and that of the male partly surrounds it. At times the male relaxes the abdomen and moves forward upon the female. Ultimately the two are so accurately adjusted—and this is a difficult problem in two such irregular, rigid masses with so many appendages—that the tips of the first pair of pleopods are thrust into the annulus.

The two are now firmly united and cannot be readily separated, in fact it was found possible to kill and preserve them in this position, and thus obtain the photographs from which the illustrations are taken. When thrown into actively boiling water for a moment, the crayfish are fixed in the normal position with no observed change, and may then be preserved indefinitely.

The firm union of the two is accomplished by the use of the hook-like spines that characterize the male of many species of Cambarus. In *C. affinis* there is one spine on the third segment, ischiopodite, of the third walking leg on each side of the body. When the male applies himself closely to the female, he fastens these two hooks to the base of her fourth walking legs, on each side.

The hooks depress the soft membrane between the coxopodite and basipodite on the dorsal-lateral aspect and catch firmly against the chitinous ridge formed by the hinge-like union of the chitinous edges of those same segments, coxopodite and basipodite. By this means the two animals are held together against the force necessary to introduce the male pleopods into the resistant annulus.

The animals now remain united for several hours, during which time sperm is transferred into the annulus or seminal receptacle of the female.

The annulus is a well known descriptive character found in the females of Cambarus, but not in Astacus: hitherto its use has not been known.

It varies in shape in different species.

In *C. affinis* its development varies, but in general it is a transversely elongated, ellipsoidal, chitinous elevation on the ventral side of the thorax between the bases of the fifth pair of walking legs. On this raised area are smaller, more prominent rounded elevations, bounding a transverse groove or pit. One of these is a gentle transverse ridge, forming the posterior lips of the groove; the other two are rather prominent bosses on the anterior lip of the groove.

Between these last is a longitudinal cleft on the middle line, opening posteriorly into the transverse groove, and not straight, but curved as it passes between the two bosses. Sections of this organ show that the longitudinal cleft leads into a small pouch or sac that, when seen from a dorsal view, projects upward into the body as a curved ridge. This sac has firm walls that are of calcified chitin and presents no discovered opening except the external slit. It is regarded as simply a pitting in of the chitinous exoskeleton.

After conjugation has taken place the annulus of the female has projecting from its groove a small plug of whitish substance that may remain for many weeks.

The same material fills the cavity of the sac in the annulus. It is a compact, paste-like substance forming a tubular sheath around a central axis or mass of granules that on examination prove to be the peculiar, radiated sperm-cells of the crayfish.

As the crayfish may be roughly handled and removed from one dish to another during the process of conjugation there is no difficulty in observing with a lens the means by which this sperm-plug is made. At this period of sexual excitement the terminal part of the vas deferens of the male is turned outward from the opening at the base of the fifth walking leg of each side and projects horizontally as a short, bent, con-

ical nozzle or penis-like organ. This organ fits exactly into the beginning of a long groove that extends along the first pleopod. The tip of this appendage is sharp and hard and is seen to actually penetrate into the cavity of the annulus. The sperm that issues from the vas deferens passes along the groove of the first pleopod to its tip and so into the annulus.

The second pleopod plays some part in the process of transfer, but this is known only by inference, not by direct observation. It has a peculiar triangular spoon at its end which is held applied to the first pleopod and it also has a terminal filament that fits nicely into the groove at the tip of the first pleopod. It may easily act to shove the sperm masses down along the groove of the first pleopod as well as to protect them from contact with the water and from going astray (which rarely happens.)

Apparently both sides of the body are active in this sperm transfer, but this is not certain.

The process of sperm transfer continues, with interruptions, for several hours, and then the male separates from the female. He first moves backward, and rising places the crossed leg back again into its normal position, and then releases the female.

During the entire conjugation the male is obviously excited as is shown by the vibrations of the anterior maxillipedes and by the very strong current of water cast out from the gill chamber by the exhalent apparatus. The female, on the contrary, is remarkably inert and shows no sign of any activity even in the respiratory organs. At times there is, however, a slight convulsive twitching of the base of the abdomen, possibly connected with sensations during sperm transfer.

The eye-stalks were also seen to move when disturbed by the claws of the male.

In two instances the dexterity and skill of the male were well shown after the first stages of grasping the female had been imperfectly accomplished. In these cases the male mounted upon the dorsal surface of the female and seized her claws with his, having failed to turn her over in proper sequence. In this unusual position the male attempted to adjust his appendages to the female and then became aware of the fact that the conditions were unusual. The male depressed the first antennæ so that they were firmly applied to the dorsal surface of the thorax of the female and bent forward by the pressure. The sensation so obtained seemed to initiate the almost intelligent action that followed. In one case the exopodites of the third maxillipede were also used in feeling the female. In about ten minutes the male turned the female

over and assumed the usual attitude seen in the figures and then continued the conjugation normally.

In accomplishing this feat the male first removed his left claw from the left claws of the female, and seized her rostrum and head region. By this means he turned her to lie on her left side while he was on her right. Next, the right claw let go its grasp of the female's right claws and seized her left claws. He was now able to turn her on the dorsal surface, and by then changing his left claws from the rostrum to her right claws succeeded in moving forward over her ventral surface as normally takes place. Ten minutes later sperm was passed and conjugation continued for some hours.

While there can be little doubt that the sperm so elaborately transferred to the annulus is subsequently used to fertilize the eggs as they are laid, this is, as yet, not demonstrated. One female deposited eggs in confinement towards the end of March, but these eggs did not develop, and part of the process was no doubt abnormal. This female was in a peculiarly sensitive state for four or five days prior to laying. During this time any approaching object, though ordinarly causing no reaction, would excite the female to active movements and the raising of the claws in an aggressive attitude. During this period the female most assiduously and diligently cleaned off the foreign deposits from the exoskeleton over the ventral surface of the abdomen and from the pleopods so that this region was conspicously white.

The fifth walking legs are employed in this function, being bent back under the abdomen and rubbed against the pleopods with an unexpected amount of precision.

During this period also the female may be found at times lying on the side or on the back, and actively moving the pleopods back and forth in a rhythmic way once in about one second. The endopodites of the third maxillipedes and the chelæ and the first and second walking legs are likewise, slightly, swung back and forth.

The actual laying of the eggs took place during a night and a day. At this time a large mass of slimy material extended like a veil from the tip of the bent abdomen to the ventral side of the thorax anterior to the third walking leg. Some of the eggs were enclosed in this mass and some in a similar mass attached to the pleopods. It would seem that the eggs could pass from the oviducts under protection of this secretion to their destination on the abdominal appendages.

This mass of secreted material disappeared entirely within two days. The eggs then remained attached to the pleopods.

The sperm-plug that was present in the annulus also disappeared a day later than the secretion. As this crayfish was alone, it seems certain that she removed the sperm-plug. It remained for weeks in cases where eggs were not laid.

The eggs, however, seem not to have been fertilized: they gradually fell off and burst from osmotic changes. E. A. ANDREWS.

PSYCHOLOGY.[1]

Professor Baldwin on "Mental Development."—It gives me pleasure to insert the following note which Professor Baldwin has recently sent me, with reference to the review of his book on "Mental Development in the Child and the Race," which was printed in the July number of the NATURALIST:

"The very cordial and appreciative review of my book on *Mental Development* by Dr. Newbold in the July issue of this journal contains one remark which a word from me may serve to throw light upon. Dr. Newbold says that I sometimes 'rest content with a careless and inadequate analysis of the psychoses which are to be explained.' This is no doubt just, as far as the actual contents of my book are concerned, and as far as the word 'inadequate' goes. But I may say that the inadequacy is due to the fact that I have already devoted my large *Handbook of Psychology*—especially the second volume on *Feeling and Will*—to the detailed analytic treatment of the same functions which are treated genetically in the present book. I did not feel justified in doing that a second time. And moreover many of the analytic results which my *Mental Development* assumes are, I venture to think, such common property of psychologists to day that they are largely outside the arena of debate: at least, whenever my developments in this book seemed to me to turn on points in dispute, I tried not to leave the justification of them in an inadequate state. I hope it is not too much to ask of readers that they bring their general psychology with them. It is really not the psychology that I fear the inadequacy of as much as the biology of the book, but however that may be, the omissions are well-considered and not 'careless.'"—J. MARK BALDWIN.

[1] This department is edited by Dr. Wm. Romaine Newbold, University of Pennsylvania.

In light of so explicit a disclaimer I must withdraw the objectionable word and ascribe the omissions in part to fundamental differences between Professor Baldwin's thought and my own, and in part to the limitations of space. I need only say that after writing but before printing the review in question I carefully reread those portions of Professor Baldwin's larger work which dealt with the topics I had in mind and failed to find what I sought. And while most of us, I fancy, bring our general psychology with us when we attempt to master a technical treatise like Professor Baldwin's, we do not all feel justified in ascribing to an author doctrines which his words, taken in their most obvious sense, would seem to exclude, however important those doctrines seem to the reader, or however widely they are accepted by others.—W. R. N.

"**The Psychic Factor.**" By Charles Van Norden, D. D., LL. D.[2]—This is a somewhat disappointing book. At the outset it challenges interest. The author finds the justification for its appearance "in the unsettled condition of the metaphysical world, in the marvelous strides of biological and psychological discovery, and the utter demoralization of the old psychology," and endeavors to cover in 217 pages the whole field of comparative and analytic psychology, with a glance aside at supernormal and pathological phenomena. The book is written in a vigorous and attractive style and the author betrays an enviable command of fact and illustration. Furthermore, it is of interest as being one of the earliest attempts to incorporate the tentative results of current psychical research into a textbook on psychology.

The earlier chapters sketch in a few words some of the more interesting manifestations of consciousness in lower forms of life, and trace the evolution of the nervous system. In the second section on consciousness in general, the author endeavors to escape from current psychological conceptions and to deal with attention, with the "enchaining and grouping function of consciousness" and with the influence of mental states on organic functions from a point of view more in harmony with the newer psychology. The third section, on subconsciousness, endeavors to bring the phenomena of hypnosis, secondary personality, etc., into line with the phenomena of normal sleep. But telepathy and clairvoyance, although acknowledged, remain patches on the garment of the author's thought. His treatment of sensation calls for no especial comment, and in his analysis of the "cognitive powers," of feeling and of will, Dr. Van Norden frankly relapses into the old psychology which he regards as so utterly demoralized.

[2] New York, D. Appleton & Co., 1884.

On the whole, "The Psychic Factor" is written in a candid and scientific spirit, yet occasionally one finds traces of the theologian and instructor of youth which would be more in place elsewhere. We are hardly yet in a position to say that the phenomena of telepathy make divine inspiration "no longer even an unlikely phenomenon;" but "one of the most feasible and natural of religious processes." Nor can we point to the still more contested phenomena of "lucidity" as establishing on the part of the Hebrew prophets a "prophetic insight," or as proving that they "surely saw visions and dreamed dreams," that "the present and the future appeared to them as a shifting panorama." The question of possibility is one thing and the question of fact another; the possibility might be established and the fact remain highly improbable. And when, in the chapter on hallucination, we find the hallucinatory properties of opium used as a pretext for a diatribe upon tobacco, we feel that there is a form of zeal that is not edifying.

The Baboon Switch Tender.—Some years ago a statement appeared in the newspapers that a baboon had been trained to open and close the switches on a South African railroad. The following extract from a letter from Klerksdorp, S. Africa, of March 31st, 1895, confirms these accounts:

* * * "you can state that until lately, when the nervous public made such a fuss it had to be stopped, a South African monkey, like those I wrote to you about from Mooit Gedaert, was tamed by a switchman just out of Maretsburg, our college town here, to turn switches for passing trains, etc. He would wait until the engine was in sight, then run and open the switch, jump on the *cowcatcher*, have a short ride, then jump back to turn it off again, but passengers grew so frightfully hysterical, especially the strangers, that it was stopped This is honestly true."—Joanus Stubbs.

Change of Habit in a Parrot.—A letter addressed to *Natural Science* by M. S. Evans, Natal, S. Africa, calls attention to a change in the food habit of the parrots (*Psittacus* sp.) in the valley of the Upper Umkomanzi River. Until last year (1894) the parrots, which are quite common in the bush, had not foraged in the gardens and orchards, when for the first time since the place had been settled by the Europeans—a matter of twenty-five years—they attacked the fruit. Their somewhat timid nature seemed quite altered, and they flew into the orchards in large numbers. They seemed unable to carry off the fruit alone, so broke the small branches below the joint, and were seen

flying off with branches with apples attached in their bills. The excitement among them seemed intense, the discovery of such an abundant and new food-supply apparently much agitating the parrot world. As the change of habit may be permanent, Mr. Evans thought a record of the date of the change worth making.

ANTHROPOLOGY.

Another Ancient Human Jaw of the Naulette Type.—In the Pyrenean cave of Estelas (department of Ariége, Commune of Cazaret, near St-Girons), associated with cave bear, horse, an ox, Cervus elaphus, and Ursus arctos, an interesting lower human maxillary has been recently found. This presented to the Academy of Sciences of Paris (see Revue Scientifique, 27th of July, 1895) by M.M. Louis Roule and Felix Regnault should cause considerable comment in view of the recent European discussion for and against the so-called ancient types of human skulls. While late observation in craniology has seemed to undermine the value of cubical measurements of brain contents as tests of age, the peculiar jaw traits of certain old skulls have apparently held their significance. This complete child's jaw is said to present manifest characters of inferiority, together with a strength and adaptability for muscular insertion remarkable for so young an individual. Moreover it has a striking resemblance to the celebrated jaw of Naulette and to that of Malarnaud (Ariége).

Sandals in Yucatan.—I asked the Bishop of Yucatan the question propounded by Mr. Otis T. Mason in Science for August 2d, 1895. whether the sandal now in common use among the Mayas, strapped across the instep and fastened further by a single round thong between the first and second toes, was an inheritance from pre-Spanish times. He was unable to answer the question more particularly than to show me from his collection, the foot of an earthen statue from Izamal, moulded with a sandal fastened by two toe thongs instead of one. These passed between the first and second, and third and fourth toes. to reach a strap on the instep. I question whether the existing san-

dals have been attentively studied in Central America. Some Indians may wear the double toe strap still, but given the existence of the sandal with double toe straps in ancient America, we might reasonably suspect that the old Mayas sometimes used the simpler single thong between the first and second toes, now so common.—H. C. MERCER.

Strange Hints for Anthropology.—Schiaparelli, who observed in 1877, the markings called canals on Mars, not yet discerned by the Government telescope at Washington, still hesitates to call them trenches dug by intelligent if not human creatures. Since his observations, the existence of the markings has been verified by astronomers at Nice, at Arequipa and at Mr. Percival Lowell's observatory at Flagstaff, Arizona, where the air medium is good for seeing, and where many more lines have been discerned and named and new phenomena studied. The theories advanced and some of the results of Mr. Lowells' original observations have been interestingly summed up by him in the Atlantic Monthly for May, June, July and August, 1895.

Mr. Lowell states the remarkable probabilities to be as follows: That the long lines, because straight and regular, are artificial; that they are visible because, as Prof. W. H. Pickering first suggested, belts of irrigated vegetation about 30 miles wide fringe them and show dark against the desert face of the planet; that they fade out in the Martian autumn and become visible in the spring because their leaves fall off and reappear; that they are dug straight because no mountains exist to obstruct them; that, granted an intelligent water drinking inhabitant, they are necessary, because Mars is waterless save for the yearly melting of a polar ice cap; that round, oasis-like areas at their intersections still further indicate methods of artificial fertilization; that, by our own standards of need, intelligent creatures could exist on Mars because Mars has an atmosphere and that owing to a less hostile gravity its inhabitants might perform more work at less pains than we do.

Meanwhile the investigation of what appears to be the handiwork of a Martian intelligence must excite wide interest. As yet no explanation is offered for the strange fact that sometimes certain canals show double. And there are other doubts. Distant trees on the earth do not always lose color. The Yucatan forest, where I have seen it from hilltops, had a distinct dark blue appearance to the naked eye in February and March, though, to a great extent, leafless, and we are left to wonder what light observations of the ocular effect of patches of

woodland upon the earth's surface from mountain heights may throw upon one of the vital points of the theory, namely, that belts of vegetation, when leafless, observed through a telescope against a bare background, would be invisible.

H. C. MERCER.